The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

DECEMBER, 1930 VOL. 15, NO. 12

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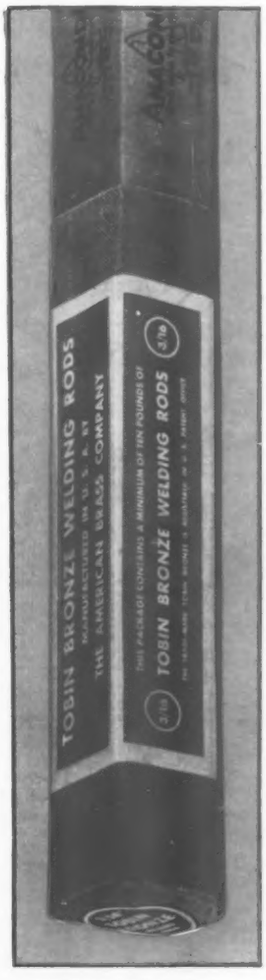

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from

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CONTENTS

Practice in Welding Turns to Research....29
By James R. Griffith
Welded Furnaces Meet All Requirements....33
Applications of Bronze-Welding....39
Training Arc-Welding Operators....43
By A. F. Davis
Hints for the Welder....55
Everybody's Business....25
By Floyd W. Parsons
Editorial....27
Roadbed and Sidewalk Frames Welded to Bridge..37
Welding Proves Ideal for Strengthening Beams....37
British Report of Welded Gas Tanks....38
Strengthening Railroad Bridges....45
Welded Repairs of Expensive Castings....47
Pressure-Vessel Seams With Welded Butt Straps..49
Huge Gas Holders Are Arc Welded....49
Welded Landing Skis for Army Planes....50
Welding Structural Steel....52
Training and Supervising Structural Welders....53
New Products....57
New Literature....59
News of the Industry....60

Inspect and Overhaul

MANY business concerns have enjoyed a real profitable year in 1930 in spite of the unfavorable conditions which have prevailed. They have done this by keeping the business machine in good running condition. Every automobile owner knows that a car which seems to run perfectly during fair weather will develop all kinds of ailments just as soon as the winter storms get into action. For this reason, a good many of them have their autos thoroughly inspected and overhauled at the first indication of cold weather. They have the oil changed, a non-freeze mixture put into the radiator, spark plugs cleaned, generator brushes adjusted, tire chains inspected for worn places, etc. As a rule these drivers keep plugging right along and pass a good many machines which are stalled in the first drifts. The business machines which were stalled in 1930 probably needed overhauling. It is not too late to get them into shape for 1931. This is particularly true of the merchandising part of the business machine. Do not wait for fair weather to make it run. Inspect, overhaul, repair, replace and readjust, and make it work while the going is bad. That is the period when a smooth-working merchandising plan and sales machine has its best chance to demonstrate real value.

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Superior Oxy-Acetylene Machine Co.
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Electric Arc Cutting & Welding Co.
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Hollup Corporation
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Bonney Forge & Tool Works

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Central Steel & Wire Co.
Imperial Brass Mfg. Co.
Lotan Research Corp.
Metal & Thermit Corp.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Torchweld Equipment Co.
Weldit Acetylene Co.

GAS SAVING DEVICES
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Harris Calorific Co.
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GASOLINE ENGINES
Continental Motors Corp.

GLOVES
Holcomb Safety Garment Co.
Ideal Face Shield Co.
Oxweld Acetylene Co.
Pulmosan Mfg. Co.

EVERYBODY'S BUSINESS

BY FLOYD W. PARSONS

IN A few weeks we enter a new decade. It will also mark the commencement of a new era. Chapter by chapter the story will unfold. It will be a tale of amazing developments in science, economics and engineering. Human nature will take care that the path of progress is strewn with colossal failures as well as huge successes. But the march will be upward. What can we definitely see ahead?

Developing a New Outlook

First, and most basic, is the matter of population. Today we have in the continental United States approximately 123,000,000 people. In 1940 we will have in our country 140,000,000 people, even after making allowance for all the important factors, including a slightly declining birth-rate and restricted immigration.

This means that we must definitely prepare to take care of 17,000,000 more people. It means an increase during this next decade of at least 14 per cent in our consumption of life's necessities. It means that we will go ahead making ourselves more independent of foreign purchases of our agricultural products.

In 1900 we had only 76,000,000 people to feed, and still we were producing nearly as much corn and wheat as we are today. All that saved the American farmer from bankruptcy, as a consequence of declining foreign markets, was the steady increase in domestic consumption brought about by our growing population. This same factor is the one great hope for agriculture in our country in the years just ahead.

What we need right now is to lay aside controversies and develop in our minds a picture of the certain advance of business and industry in the decade just commencing. A careful and conservative estimate indicates that in 1940 we will be using or consuming annually 2,000,000 more bales of cotton, 4000 billion more heat units, 120 more horsepower per 1000 of population, 2,000,000,000 more pounds of sugar, 6,000,000 more tons of iron ore, 1,250,000,000 more pounds of copper, 11,000,000,000 more gallons of gasoline, 312,000 more tons of rubber, 3,000,000 more motor cars and trucks, 70,000,000 more barrels of cement, and at least 34,000,000 more pairs of shoes.

This estimate of future probable growth might be extended into dozens of other fields of activity. In the next ten years we may expect the installation of 7,000,000 more telephones and the addition of 40,000,000 miles of wire.

Various kinds of apparatus will add color to television, employ invisible light to hunt icebergs, use a light-beam to stop locomotives, transmit typed letters by wire, enable airplanes to pick up mail while in flight, lay railroad ties without human aid, match colors, peel pineapples, record the activities of bees and compute the height of clouds. Huge steel monsters will gulp iron ore and delicate mechanical ears will detect airplanes ten miles off.

Microphones and loudspeakers will speed up operations in mills and factories. Hydrogenation, aided by the presence of gaseous hydrogen and certain catalytic agents, will make possible the production of a gallon of gasoline from a gallon of crude oil. The Aston process, now reaching the early stages of production, will double and triple the consumption of wrought iron by cutting the cost of this product. A vast system of pipe lines carrying liquid and gaseous fuels will change the whole complexion of our heat and power industries.

The idea that we are reaching points of saturation in most directions is fallacious. For instance, take the matter of road building. In spite of the tremendous highway-construction program of the past few years, four-fifths of our 3,000,000 miles of highways consist of dirt roads. We have to date only about 70,000 miles of sheet asphalt and concrete roads in the United States.

We have before us the big job of eliminating grade crossings. Such crossings are not only dangerous, but cost tens of millions of dollars in wasted time by slowing up motorists. And when we consider remedies for traffic congestion, there is no avoiding the conclusion that a great many of our present highways will have to be doubled or tripled in width.

New industries, and many that are now in their infant stages, will soon be showing rapid expansion. Among these may be mentioned refrigeration; electronics; aeronautics; plastics; farm fertilization; the use of radio in business; railroad electrification and store-door deliveries; the extraction of more commercial products from coal, oil and natural gas; flood illumination to make the sports industry a night business as well as a daytime occupation; and air conditioning.

Willis Carrier, the daddy of air conditioning, says:

"The manufacture of weather by a single source of energy functioning through automatic machinery will exercise a national influence on living standards. Individual efficiency will be increased, health improved and life prolonged. Air-conditioning in the tropics will doubtless cause a redistribution of production tending to establish many manufacturing processes at the sources of raw materials. Basing our predictions entirely on existing trends and developments, it is safe to say that we will soon have hospitals that are cool and comfortable in summer; subway trains minus the present stifling heat and polluted air; steamships operating in tropical waters with cool staterooms; railroad cars, each manufacturing its own weather as it runs; and legislative halls where our lawmakers will be able to carry on their labors in an atmosphere that fosters efficiency. Weather control in the field of manufacture has a tremendous future and is sure to take its place as one of the great businesses of our country. More than 200 industries already depend upon air-conditioning to produce their goods. The extension of this principle to hundreds of other manufacturing processes will result in better products, lower costs and reduced prices. Manufactured weather applied to office buildings will give us immovable windows, thereby shutting out dust, dirt and street noises. The lower floors of these buildings will become as valuable as the upper stories."

If the automobile industry goes ahead a little more slowly, we may be sure that aeronautics and other infant developments will more than make up for this slackening of momentum. We must have hundreds of new airports, many of which will cost at least a million dollars. Most of the present fields could easily take care of 20 times the volume of traffic that now goes in and out of them. It is interesting to know that airports are under discussion in 375 cities today.

The foregoing represents merely the briefest kind of mention of facts that bear directly upon the course of trade in the United States in the years immediately ahead. The upturn in business may not be nearly as slow as a lot of fearsome souls are inclined to believe, and a lack of preparation may be fatal.

The Harris "Red Head" meets every demand of Convenience, Economy, Safety and Portability.

About 100 cu. ft. of pure gas.

It sells for the amazingly low price of $50.

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Suppose the VOLUME of business does fall off? PROFITS can be kept up by finding ways to reduce operating costs. Investigate the Harris Red Head Acetylene Generator. It brings the cost of acetylene gas down to about a cent a foot.

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2. Its cost is trifling compared to its value.
3. Makes about 100 cu. ft. per charge.
4. It HAS EVERYTHING you want in a first class generator.
5. Approved by Underwriters.

Write for literature, or ask for a demonstration.

HARRIS CALORIFIC COMPANY
Cleveland, Ohio

HARRIS *Red Head* ACETYLENE GENERATOR

EDITORIAL

Changing the Industrial Picture

DURING the past month, two inquiries were received from men in different localities who indicate that they are in need of much information because of important changes in local conditions. In both cases, the local changes are due to the laying of a transcontinental pipe line for carrying natural gas and making it available to new communities along the line. This new gas line, it is stated, promises to revolutionize the industrial picture in some communities. Old industries are benefited and are able to increase their operations with a decrease in cost, and new industries are being attracted which in turn promises to increase local populations to the extent of necessitating a considerable amount of new home building. The welding contractor thus receives a new volume of business and a new type of business. The manufacturer of welding equipment and the welding supply dealer find their markets increased. This all goes back to research work done a few years ago in the field of pipe welding and pipe-line welding. It is a splendid example of how far reaching can be the effect of a single new development in welding practice.

Oxygen and Acetylene Production in 1929

ON November 6th the Bureau of the Census issued a bulletin on the production of compressed and liquefied gases, which showed increases in the production of oxygen and acetylene since 1927 as follows: The production of oxygen in 1927 was 2,359,896,000 cu. ft., valued at $23,986,881; the production of oxygen in 1929 was 3,044,317,000 cu. ft., valued at $23,231,701. The production of acetylene in 1927 was 682,481,000 cu. ft., valued at $16,196,388; the production of acetylene in 1929 was 989,228,000 cu. ft., valued at $16,282,395. The gas welding and cutting industry will welcome this evidence of steady growth in the demand for these two gases.

Steel-Building Progress in Germany

GERMANY is developing a distinctly new architecture, based upon steel construction, according to Otto Von Halem, of Dusseldorf, Germany, who addressed the eighth annual convention of the American Institute of Steel Construction. He related that the first buildings with steel framework were erected in the beginning of the 19th century and showed all the typical features of the wooden-frame house. Such buildings were for a long time confined purely to industrial buildings, shops, warehouses, and the like. There has been a gradual development toward new designs and this has been paralleled by the development of new steel building materials. These changes in materials apply to both the composition and the shape of the steel members now used, and welding has played an important part. By making special sections for steel windows, door frames, doors, partitions, store and shop equipment, show windows, etc., with seamless and welded tubes for different requirements, the list of building materials has multiplied. A special kind of light section is made of cold-drawn strip steel and is being used in one, two, and three story buildings and for the upper stories of higher buildings. Two of these strip steel sections welded together form a light joist for floors in buildings carrying light loads. Welding, in place of riveting or bolting, has more recently been introduced. A number of structures have already been welded and further improvements are expected. Herr Von Halem states that the leaders of the steel industry in Germany do not feel that it is enough merely to erect a good steel frame, or even an excellent steel frame. They believe that a house is a unit whose component parts cannot be treated separately, and only by proper correlation of all component parts can perfection of the whole be attained, and that this necessitates the consideration of house building from a broad point of view. As an example of the success obtained in cost reduction, there is cited a recently completed steel-frame apartment house in Berlin showing a saving of 11%, and another near Hanover showing a saving of 16%, as against brick houses of the same size. Present applications of steel in the building industry include industrial buildings, offices, dwellings, churches, and schools. It is interesting to note also that the architecture of steel structures in Germany is slowly freeing itself from conventional forms and is striving to attain shapes which conform with the possibilities of steel construction and with hygienic requirements.

Georges Claude Draws Power from Tropical Seas

THE December issue of *Mechanical Engineering* contains George Claude's own story of his pioneer work in utilizing the difference between temperatures of ocean water at the surface and at lower depths as a source of power. The experimental plant described in the article required the submerging of a line of 6-ft. pipe a mile and a quarter in length. George Claude is a scientist and inventor who has contributed much to the welding industry. He devoted many years to research and invention leading to the development of the liquefaction of air and oxygen and the process for dissolving acetylene in acetone and storing it under pressure. The processes whose progress was made possible by his inventive genius were evidently brought into use in his new field of experimentation, for he speaks of using tubes made of welded Armco sheets. The result of the experiments carried on this year have proved that it is possible to obtain power in this manner, and this eminent inventor has confidence that the future will see greater developments along these lines.

Meeting the Demand for Beauty in Bridges

WHILE admitting that the public conception of ordinary highway bridges of simple span is not favorable to steel, it is still possible to design steel structures of such outstanding beauty that they will be beyond competition of other materials, is the opinion expressed by P. H. Wood, Vice-President of the Converse Bridge and Steel Co., Chattanooga, Tenn., in a recent talk before The American Institute of Steel Construction. "If we are to build bridges of outstanding beauty," said Mr. Wood, "why not adopt a tubular section for an arch rib or a tube chord section, or for that matter web members also. It may be that curved tubular sections can be most economically fabricated by welding. Welding is rapidly being accepted as a satisfactory method of joining steel members. Rivet heads and gussets are not pleasing to the eye. A welded joint can be made much neater and curved members can be fabricated much more easily by welding. At least it is worth a trial. Furthermore, some form of welded steel deck floor might be adopted with a great saving in dead weight." In urging members of the Institute to be open-minded in their approach to the problem of designing bridges in the future, a definite plea was made to give consideration to the use of welding or any other modern methods necessary to accomplish the desired purpose.

STOODITE
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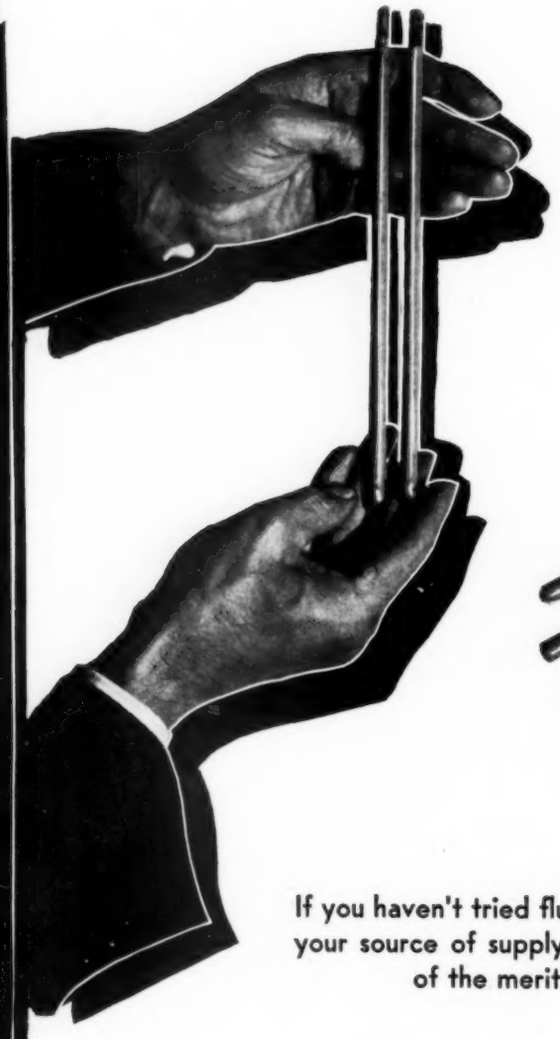

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WHITTIER · CALIFORNIA

Practice in Welding Turns to Research*

Students and Faculty at Oregon State College Conduct Original Investigations Into Problems Relating to Applications of Welding

By James R. Griffith†

INSTITUTIONS such as Oregon State College have many problems of education outside of regular class-room work. Welding, as now practiced, is relatively new. In order to assist in the education of the public, a second welding conference was promoted at the college in February, 1930. George B. Cox, professor of industrial arts, was in charge. His untiring spirit and encouragement contributed to a large degree to the success of our experimental work in welding.

Many Questions Still to Be Answered

I was asked to prepare a paper raising some of the pertinent questions in the application of welding to the structural-engineering field. While preparing the paper, I raised many questions for which no answer could be found. So it was decided to try to answer some of the questions by what limited research we could do with the funds available. Little was it realized what we were getting into. The questions are still coming up at an alarmingly rapid rate. Each answer seems to originate many questions.

It fell to my lot to design the test specimens and put the wheels in motion. Commercial organizations cooperated in the preparation of many of the test specimens. The rest were prepared in the school forge shop.

The college forge shop is very well equipped to do gas welding and has been giving instructional work in it for two years. Ten welding stations are supplied by a standard 300-lb. acetylene generator. William H. Horning, instructor in forging, is in charge of this work and is doing some remarkable ornamental welding. He is not only a master of the art himself, but is able to teach others. Each student chooses a project, usually some ornamental work which he can take home and use. He is charged only for the actual materials used. As a consequence, little structural welding is being taught.

Last year, one of my senior students found a new application for welding wire. He fabricated a model of a mill-bent from welding wire and used it to analyze the reactions from wind loads. His paper on the subject won a prize offered by the Portland Section of the American Society of Civil Engineers.

When the various structural test specimens were fabricated, they were sent to the college material-testing laboratory. J. C. Othus, assistant professor of mechanics and materials, was in charge of this phase of the work. Professor Othus, assisted by Clarence Robinson, senior in the school of civil engineering, did all the actual testing.

A few days before the opening of the welding conference, I became interested in the subject of non-destructive tests of welds. One of my senior students, John Reiff, was put to work on the problem. This fall the experiments are being continued by R. G. Robey, senior in civil engineering, and J. R. Batcheller, senior in electrical engineering. A. L. Albert, assistant professor of electrical engineering, has given us much help and advice.

Few of the ideas originated in the mind of any one individual. Most of the ideas were collective, as was all the work. Only by the whole hearted cooperation of all could we have accomplished a thing. This is the more remarkable when I tell you that this type of work must be done outside of class-room time. We all carry schedules which are intended to keep us busy.

Effect of Operator's Skill on Welds

The first question to be raised was: *How much does the strength of a gas weld depend upon the skill and experience of the operator?* Plenty of amateur welders were available among Mr. Horning's students. They prepared test specimens. Several commercial organizations prepared similar specimens to be used for comparison.

These specimens, consisting of welded plates, were sawed into 1-in. strips for convenience in testing. The actual area in each piece was measured, and then broken in tension. The results are given in Table 1. We were more than gratified by the results. Structural engineers have come to look with confidence upon riveted connections. If amateurs, picked at random, can make such a showing, why worry about the reliability of a welded joint? Rolled structural shapes vary more than this. Few stress computations are as accurate.

Table 1. Comparative Efficiencies of Amateur and Professional Gas Welds.

Specimen No.	1	2	3	4	5	6	7	8	9	Eff.
Professional	100	100	100	98.5	98.5	100				99.5%
Amateur	100	90	100	99	99	99.8	90.7	100	96	97.1%

$$\text{Efficiency} = \frac{\text{Ultimate load to break specimen}}{\text{Computed strength of member}}.$$

Another question then came up. *What is the learning, or efficiency, curve of a beginning welder?* If, for instance, an individual without previous experience or knowledge was told how to make a gas weld, and then permitted to make one, what would be the efficiency of the joint? Then at hourly intervals, representing increased decrees of experience, if samples were made and tested, what improvement would be shown? How fast will his efficiency curve climb? How many hours before he can attain 100% efficiency, or make a weld as strong as the member? Beyond that point, little is to be gained except speed. Here lie interesting possibilities I know. But so far we have had neither the time nor finances to do it.

The next question to arise was: *How do welded structural connections compare with riveted?* I had been giving some thought to standard methods of riveting connections, and could think of many points for comparison with welded connections.

When connecting a single leg of an angle to a gusset plate with rivets, flexural stresses are set up upon application of a load. The flexural stresses are due to the eccentricity of the connection. I can best demonstrate the effect of an eccentric load by the use of a steel band, or spline. The spline was connected at each end to wooden blocks. Pins were inserted off center from the spline by a distance e. Now, if a pull is exerted by way of the pins, a bending moment is induced, by the eccentricity e and the load, equivalent in magnitude to $M = P\ e$. The bending moment sets up flexural stresses of tension and compression, indicated by the bent spline. It will be noted that the central portion

*Read before the 31st annual convention, International Acetylene Association, Chicago, Ill., November 12-14, 1930. Slightly abridged.

†Professor of Structural Engineering, Oregon State College.

of the spline seeks to attain the line of the pull. Nature tries to remove the eccentricity.

Study of Eccentricity of Angle Connections

When the leg of an angle is riveted to a gusset plate, the connection does not coincide with the center of gravity of the angle. The connection is eccentric. As a load is applied, flexural stresses are set up in both legs. Some authorities have recognized this fact and reduced the allowable load. But just how serious is it? I am afraid most designers have made just a guess. Some authorities consider the use of a lug angle as removing this objectionable eccentricity. Others claim it is of no value.

If this condition exists in riveted connections, is it to be found in welded connections? Theoretically, the eccentricity could be avoided in one leg by the proper distribution of the weld, but does it actually do this? Would the use of a lug angle remove the eccentricity in the outstanding leg? I could find no answers. Previous tests had been on short-length members. Experimenters had been more interested in the strength of the weld than the stresses set up in the member itself.

In order to allow for the longest possible length of angle which the testing machine would take, we were practically limited to the use of a $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{3}{8}$-in. angle. The connection was made at each end by means of two bars so as to eliminate all possibility of torsional stresses from the testing machine.

It might be well to mention how the unit stress was determined at the various locations. As a load is applied to a steel member, up to a certain point called the yield point, unit deformation is proportional to unit stress. The ratio of stress to deformation, called the modulus of elasticity, can be accurately determined. If this ratio is known, and the unit deformation (stretch) is determined, the unit stress can be computed. The Berry strain gage was used to determine the unit deformation.

So-called gage stations had been laid out along the angle before it was put into the testing machine. The system of designation and location of the various gage stations is shown.

Readings were taken over the entire angle and connections. As was expected, the intensity of stress increased from the connection to station line *L*, half way between connections. Critical values along station line *L* are given in Table 2. Station 1 was close to the edge of the connected leg. Station 4 was close to the V of the angle. Station 6 was close to the edge of the outstanding leg.

Table 2. Unit Stresses in Section Midway Between Connections.

	Without Lug Angle			With Lug Angle		
Station No.	1	4	6	1	4	6
Load, Lb.	Unit tensile stress in thousand lb. per sq. in.					
Riveted—						
20,750	33.9	30.5	20.0*	38.7	35.0	16.9*
25,300	YP+	36.7	24.0*	YP+	YP+	18.8*
Welded—						
20,750	20.4	YP+	15.1*			
25,300	23.7	YP+	22.5*			
31,200	23.4	YP+	32.4*	23.7	YP+	17.9*

YP+ indicates stress above yield point. *Compressive stress.

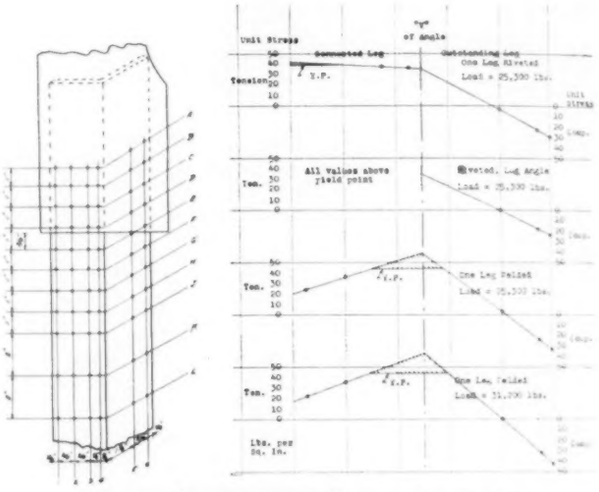
Total load (18,000 lb. per sq. in. on net section)	25,300 lb.
Total load, reduced for eccentricity (82% of 25,300)	20,750 lb.
Total load (18,000 lb. per sq. in. on gross section)	31,200 lb.

In making a comparison, please remember that the various loads applied were determined by customary methods of computation. In each case, the intention was to have the unit stress not exceed 18,000 lb. per sq. in.

I regret that the tests are not as complete as I would prefer. Perhaps in the future we may find financial means by which to carry the research to more complete results. However, for the tests made, the results were surprising to all of us.

When the yield point was exceeded, the strain-gage reading did not give the actual stress. At these points, no value is tabulated. So I have tried to show by means of curves how seriously the yield point was exceeded by plotting stress curves along station line *L*. Assuming straight-line variation, lines were drawn through the plotted points, giving some idea of the stress beyond the yield point. Strictly speaking, these curves more nearly represent the deformation. Beyond the yield point, unit stress is not proportional to unit deformation, so the actual stress is somewhat below the limit shown in the cross-hatched portion. The curves at least permit of comparison between joints.

The results would seem to indicate that, for the working load, the stress distribution of the welded joint is little, if at all, better than for the riveted joint. Of course it must be remembered that the unit stress at the minimum section of the riveted connection has not been shown—and this section is the weak point.



(*Left*) **Locations of Gage Stations on Test Specimen.**
(*Right*) **Curves Showing Stresses in Legs of Angle.**

Better Method of Weld Distribution Needed

The welded connection seems to indicate more eccentricity in the plane of the connected leg than does the riveted member. I question the correctness of the present method of figuring the weld distribution for the angle connection. I am not so sure it cannot be improved. But this demands research, and so far we have not had the funds with which to try it.

When tested to final destruction, the gas-welded specimens, as was to be expected, made a much better showing than the riveted ones.

The strength of any weld depends largely upon the skill and care of the operator. Material may be carefully standardized. But if the right heat is not applied, the best of materials are of little use. I note that in some recent welded structures, the operators were required to pass periodic examinations on their ability to make satisfactory welds. Any operator who could pass the first test could surely pass any others. And he would be foolish not to put his best efforts into the test weld. But what will he do on the actual structure? Understand, this is no criticism of welding operators alone. It is more a criticism of human nature. I have been on too many construction jobs not to realize that the best workman is careless at times. How are these careless welds to be located?

In the January, 1930, issue of *Oxy-Acetylene Tips*, an article described how welds might be tested by using a doctor's stethoscope. I obtained a stethoscope and began to

make myself obnoxious to the other occupants of the building with my tapping. I then conceived the idea of demonstrating the method to the welding conference. To let each member listen with the stethescope was out of the question. So, with the help of the electrical engineering department, we set up an amplifier and loud speaker. The sounds were magnified so all the audience could hear it. At the present writing, we are still tapping—but with an amplification that sometimes resembles the din of a boiler shop. But one question leads to another. We are still searching, and expect to continue for some time if we are not thrown out for disturbing the peace.

COMPRESSIVE TESTS OF COLUMN BASES

The results of tests on bases formed of welded or riveted plates and angles at the bottom of H-sections, are given in research paper No. 218, of the Bureau of Standards, entitled "Compressive Tests of Bases for Subway Columns," which may be obtained from the Superintendent of Documents, Washington, D. C., at ten cents a copy.

Three of the bases put under test were welded and six were riveted. The H-sections used in all the tests were 6-in., 50-lb. rolled sections, 2 ft. long.

Each of the welded bases consisted of two ¾-in. stiffener plates of triangular shape, 1 ft. high and 6 in. wide at the base, with the vertical side welded to the flange of the H-column, and the entire assembly welded to a ½-in. base plate extending under the column and angle plates. Half-inch fillet welds were laid on both sides of each triangular-shaped plate and along the outside bottom edges of the column flanges.

Three of the riveted bases consisted each of six angles and two plates, the base angles (6x6x⅞ in.) being assembled to the flanges of the H-section, plates mounted against the column flanges above the angles, and two vertical stiffener angles (6x4x⅜ in. by 11⅝ in. long) used on each side, with the entire assembly riveted to the flanges of the H-section. Three other riveted bases were tested, these being of like construction except with the addition of ½-in. base plates. The 6-in. legs of the inside angles acted as stiffener plates, much the same as the angle plates used in the welded construction.

The specimens were loaded with the base on a span of 12 in. Strain-gage readings were taken to study the stress distribution.

Failure in the welded specimens was produced at an average total load corresponding to a stress of 44,200 lb. per sq. in. in the H-section; while for the riveted specimens with base plate, this figure was 46,600 lb. per sq. in. The computed average maximum stress for the riveted specimens without base plate was only 28,600 lb. per sq. in. The average stress at the "yield point" of the welded specimens was almost 30,000 lb. per sq. in., and that in the case of the riveted specimens with base plate was practically the same figure. The "yield point" was obtained by observing either the load at which the beam of the testing machine "dropped" or the load which remained constant as the specimen shortened.

The first indication of failure in the welded specimens was buckling of the stiffener plates. The H-section deformed as the load increased. In only one of the specimens was a crack in the weld detected, and this was so small that it could have no effect on the results of the test of that specimen.

All the riveted specimens without base plates failed by shearing the eight rivets on one side. There was no noticeable deformation of the H-section nor of the pieces forming the base. In the case of the riveted specimens with base plates, the failure was similar to that of the welded specimens; the outstanding legs of the stiffener angles buckled, several rivets sheared, and the H-section deformed.

As there was considerable deformation of the H-sections for the base-plate specimens, welded or riveted, and comparatively little deformation of the base, it is probable that the maximum load was determined by the strength of the H-section.

As the H-sections were only 2 ft. long, their compressive strength is considerably greater than actual columns of greater length and of the same section. Also, the bases were supported on blocks spaced 12 in. center to center, and hence were tested under more severe conditions than where they rest on flat surfaces, such as occurs in practice. It is safe to conclude, therefore, that the bases provided with base plates, either riveted or welded, are amply strong.

WASHINGTON STATE COLLEGE ISSUES REPORT OF WELD TESTS

"A Study of Welded Metals Under Fatigue Tests," by G. E. Thornton, is the subject of a report recently published as Engineering Bulletin No. 34 by the State College of Washington, located at Pullman, Wash. The object of the tests described was to compare the different types of welds in which a failure of the specimen occurs when subjected to a continuous series of stress reversals. The tests were undertaken by the Engineering Experiment Station of the State College of Washington in cooperation with the Mechanical Engineering Department of the same institution and with the American Welding Society. The field covered in this work consists of tests of oxy-acetylene welds, resistance welds, and flash welds, and some work on atomic-hydrogen metallic-arc welds. The publication mentioned above is the first progress report made on this series of tests. It indicates that welded specimens from fire-box steel do not equal the endurance limit of that material unwelded. It is stated in the report that the reasons are: First, non-homogenous structure due to oxide spots and pits caused from gas inclusions; second, difference in grain structure between the metal in the weld and the metal in the original bar; and third, the difference in hardness between the metal in the weld and the metal in the original bar. It is stated that the study will be continued with tests on the different types of shielded metallic-arc welds and on specimens of all types of welds which have been uniformly heat treated.

BOOK REVIEW

STANDARD MANUAL ON PIPE WELDING.—This new manual which has been prepared and published by the Heating & Piping Contractors' National Association, New York City, has been prepared for the benefit of architects, engineers, heating contractors, steam fitters, helpers and apprentices. It is very complete in its detailed information covering the fundamentals of the oxy-acetylene welding process and the engineering data which would govern the use of the process in piping installations. One section is devoted to a complete treatment of the apparatus, equipment, materials, and supplies used in pipe welding. This is followed by a section devoted to the mechanics of welding, starting with the assembly of the apparatus and finishing with testing of the workmanship of the individual operator. The fourth part is devoted to material and data on welding construction. This includes design and layout information, management problems, and operating problems. An appendix includes specifications, engineering data, precautions and safe practices, a glossary of important terms, and a working outline for welding instructors. It is obvious that some of the best engineering and mechanical ability and talent in both the heating and welding industries have been drawn upon in the preparation of this manual and that nothing has been spared to make it a thoroughly complete and authoritative work. It has 280 pages, is substantially bound in flexible fabrikoid, and will be sold by the Association at $5.00 per copy.

THE LARGEST TORCH IN THE WORLD

By Stuart Plumley

Chief Engineer, Smith Welding Equipment Corp., Minneapolis, Minn.

A very interesting experiment was recently accomplished at the plant of the Smith Welding Equipment Corp., located in Minneapolis, Minn., involving the production of an unusually large oxy-acetylene flame.

Elmer Smith, president of the company, has had under consideration for quite some time the use of a large oxy-acetylene flame in connection with the breaking up of concrete in the wrecking of buildings. It was his desire to learn how large a single oxy-acetylene flame could be produced, and whether or not the oxy-acetylene equipment normally available would be of sufficient size to supply such a flame and maintain it for definite periods of time under working conditions.

Therefore, an unusually large oxy-acetylene torch was designed and constructed, which is believed to be the largest torch in the world. This torch was designed using the same proportions and principles which are common in the design of smaller torches, and great care was taken in both the

6½-Ft. Torch Built for Experimental Purposes.

engineering and experimental departments of the Smith Welding Equipment Corp. to make the torch conform in every respect to the standards of modern torch practice.

Some of the details of the torch are interesting. The over-all length, including the tip, is 6½ ft. The weight is 35 lb. The length of the luminous cone of flame is 3 in., and the length of the envelope of the flame is 3 ft. The gas consumption of the torch is about 600 cu. ft. of oxygen and 600 cu. ft. of acetylene per hour. The torch was operated from an oxygen manifold of four 220 cu. ft. cylinders of oxygen, and from a 300-lb. Smith acetylene generator.

In the illustration, the generator is shown at the extreme left and next to it the four oxygen cylinders connected to a manifold. Separate lines of pipe were run to the extreme right of the photograph, where the lines terminated in two globe valves and two ½-in. check valves; the hose connections and the hose were attached at this point. Hose of ½-in. size was used, and the hose connections were constructed in accordance with the new large-hose-connection standards of the International Acetylene Association.

The torch having served its experimental purpose is now on exhibit at the general office of the Smith Welding Equipment Corp. in Minneapolis. It is believed that for many years it will remain the largest torch which was ever constructed.

ANNUAL REPORT OF PROGRESS IN FIELD OF GAS WELDING AND CUTTING

The use of oxygen and acetylene in the welding and cutting of metals is holding its own in the many industries utilizing these processes, and in certain industries it has been extended to new applications which indicate a continually increasing use of these gases. This is the theme of the anuual report of the Oxy-Acetylene Committee of the International Acetylene Association, presented before the annual meeting of the association, held in Chicago on November 12th to 14th. As in previous years, this report is printed in booklet form for distribution to those interested in the use of the welding and cutting processes.

The booklet contains 73 pages and covers such industries as aircraft, automobile, boiler-making, chemical, refrigeration, railway, foundries, welding shops, lumber, oil, power-production, and others. Some industries using the oxy-acetylene torch are omitted from discussion only because the status of welding in these cases has offered nothing in the way of "news" during the year just past.

The first sections in this report deal with the progress made in design and care of equipment, growth of markets, new developments and uses of accessories, research, training and testing of welders, and procedure control. Other topics given consideration are the advances made in the use of bronze for welding and the welding of strengthened copper alloys, the increasing applications of "hard facing" and "hard setting," heat treatment, mechanical welding, the process known as metal spraying, which holds interesting possibilities as an important market for the consumption of compressed fuel gases, machine cutting, the outlook in pipe-line welding, application of welding and cutting gases to structural steel, and the status of welding applied to unfired pressure vessels.

Practically every user of the welding and cutting processes will find much in this booklet of value to him, and there will be suggested to him new ways in which the oxy-acetylene flame can cut corners in production and maintenance work and reduce costs.

Copies of this booklet may be obtained from the headquarters of the International Acetylene Association, 30 East 42nd St., New York, N. Y.

PROPOSED CODE REVISIONS RELATE TO WELDING OF UNFIRED PRESSURE TANKS

In a recent revision of Par. U-23 of the A. S. M. E. Code for Unfired Pressure Vessels, which is now effective, the following statement is made:

"All joints in vessels covered by this Code and of any dimensions may be fusion welded provided that in addition to meeting the requirements for material and design, they will conform to specifications now being prepared for inclusion in this Code, based on those which have been published under the heading, Proposed Specifications for Fusion Welding of Drums or Shells of Power Boilers."

In addition to the specifications referred to, certain revisions are proposed to make the rules in Par. U-23 more widely applicable, and it is intended further to extend the scope of the rules covering vessels which may be fusion welded without being stress relieved.

The committee is considering amplifying the Code so as to make it apply to vessels operated at temperatures of over 600 deg. F., and the inclusion of the allowable working stresses for higher temperatures. The committee is also considering the classification of pressure vessels; and should a classification be adopted, these specifications are primarily intended to cover the class of vessels demanding the highest type of construction.

Welded Furnaces Meet All Requirements

The Enameling of Parts for "Hotpoint" Appliances Involves Welded Equipment From the Start of the Process to Its Finish

WELDED joints were employed in the structural members and the conveyor system in the first U-type continuous vitreous-enameling furnace ever constructed to run up-hill. The use of arc welding not only resulted in a considerable saving in cost, but the welded joints have withstood the rigors of furnace operation so successfully that a second furnace of quite similar design has been erected, in which welding is used almost exclusively in the joint design. Both of these furnaces are in the plant of the Edison General Electric Appliance Co., manufacturers of "Hotpoint" electric appliances, at 5600 Taylor St., Chicago, Ill.

The original furnace, views of which are shown in Figs. 1 to 6, was erected completely in position out in the open, and then an extension of the factory was built over it. The new furnace, however, was built under the factory roof.

Both furnaces are of the inclined type, with the burning chamber at the upper end. The heated gases, because of their buoyancy, are trapped at the upper end, resulting in very little heat loss at the open ends of the furnaces. Each of the approaches is about 40 ft. long, and the furnace floor rises 6 ft. 8 in. in this distance. The over-all length of the furnace is about 60 ft. The burning chamber is heated by electricity and forms the curved part of the U.

The enameled material is conveyed on all-welded nichrome racks suspended from a continuous chain which is equipped with trolleys running on top of the lower flange of an overhead I-beam. Insulation protects all steelwork from the intense heat of the furnace; but the welded nichrome racks are fully exposed to the burning-chamber temperature of 1,500 to 1,600 deg. F., then cooled to almost room temperature, and again subjected to the furnace temperature, and so on, a temperature cycle being completed each time the rack makes the circuit of the conveyor. Each furnace has its own conveyor.

Design of Conveyor System

Outside the furnaces, the conveyors are suspended by angle sections hung from the factory ceiling, with channel cross pieces welded on. The conveyor track consists of I-beams cut to length and bent to shape and butt welded, on the lower flange of which ride the trolleys of the carrier connected to a continuous web chain. Each rack is carried on a rod suspended from the conveyor chain.

All steel in the furnace itself is protected from the heat by means of insulation. The conveyor chain travels above the insulated ceiling of the furnace, as Fig. 6 shows. In this view the insulation had not yet been applied to the ceiling. The suspension rods for the racks move between two strips of rolled steel which are suspended from the furnace cross beams by means of short lengths of steel welded to the cross beams and to the protective strips.

In the new furnace, the chain carries below it a series of small plates of heat-resisting material, each plate overlapping one adjacent to it. These plates, which are shown clearly in Fig. 7, slide over the slot in the furnace ceiling along which the rack rods pass, thus completely protecting the trolleys, chain, and I-beam track from the radiant heat of the furnace, and preventing dirt and grease from dropping from the conveyor chain and track onto the enameled parts on the racks.

At the entrance and exit of the furnace, the ceiling is considerably lower than the furnace chain and track, as can be seen in Fig. 4. Hence, the slot in the ceiling for the passage of the rack arms is extended upward to cover the carrier by using sides of sheet metal welded to the flanges of a channel section which in turn is welded to the cross beams of the furnace directly over the I-beam track. In the extension to the new furnace, shown in Fig. 10, cast shoes of special section are bolted to each side of the long, narrow compartment inclosing the conveyor chain and track, and the plates on the chain slide on these shoes.

The conveyor trolleys are equipped with ball bearings. Although the trolley track is only 2 ft. 6 in. above the roof of the burning chamber, the long, narrow compartment containing the trolleys, track, and chain is so effectively protected from the furnace heat that no trouble whatever has been caused by overheating.

Welded Construction of Furnaces

The furnaces are supported by welded 8-in. I-beams at the rear, these being reduced to 6-in. size at the front of the furnaces. These are used as uprights and cross beams. The over-all height of each furnace at the rear is 16 ft. The electric control panels, shown in Fig. 3, are located on the factory floor, under each burning chamber; thus the leads to the heating elements are very short.

Calcite rods suspended from the cross beams hold the roof tile in place. In the original furnace, a middle wall separates the two legs of the furnace. Archways in this wall act as baffles and tend to keep a gradual temperature gradient between the open end of the furnace and the burning chamber; this wall also supports the middle section of the roof. The inclined floor is constructed of refractory brick laid as a series of steps.

The new furnace, on the other hand, has the floor sloped, instead of being constructed in steps, and the middle wall is done away with, the baffle effect of the arches being accomplished by means of a series of vertical plates made of a heat-resisting alloy, which extend across the space between the two legs of the furnace.

This new furnace also has an extension on the front, 24 ft. long, for the purpose of checking heat losses through the open ends of the furnace, this extension being shown in Fig. 10. The floor of this extension consists of a base of concrete to which has been added some Ceilite, this being overlaid with steel plates with welded seams.

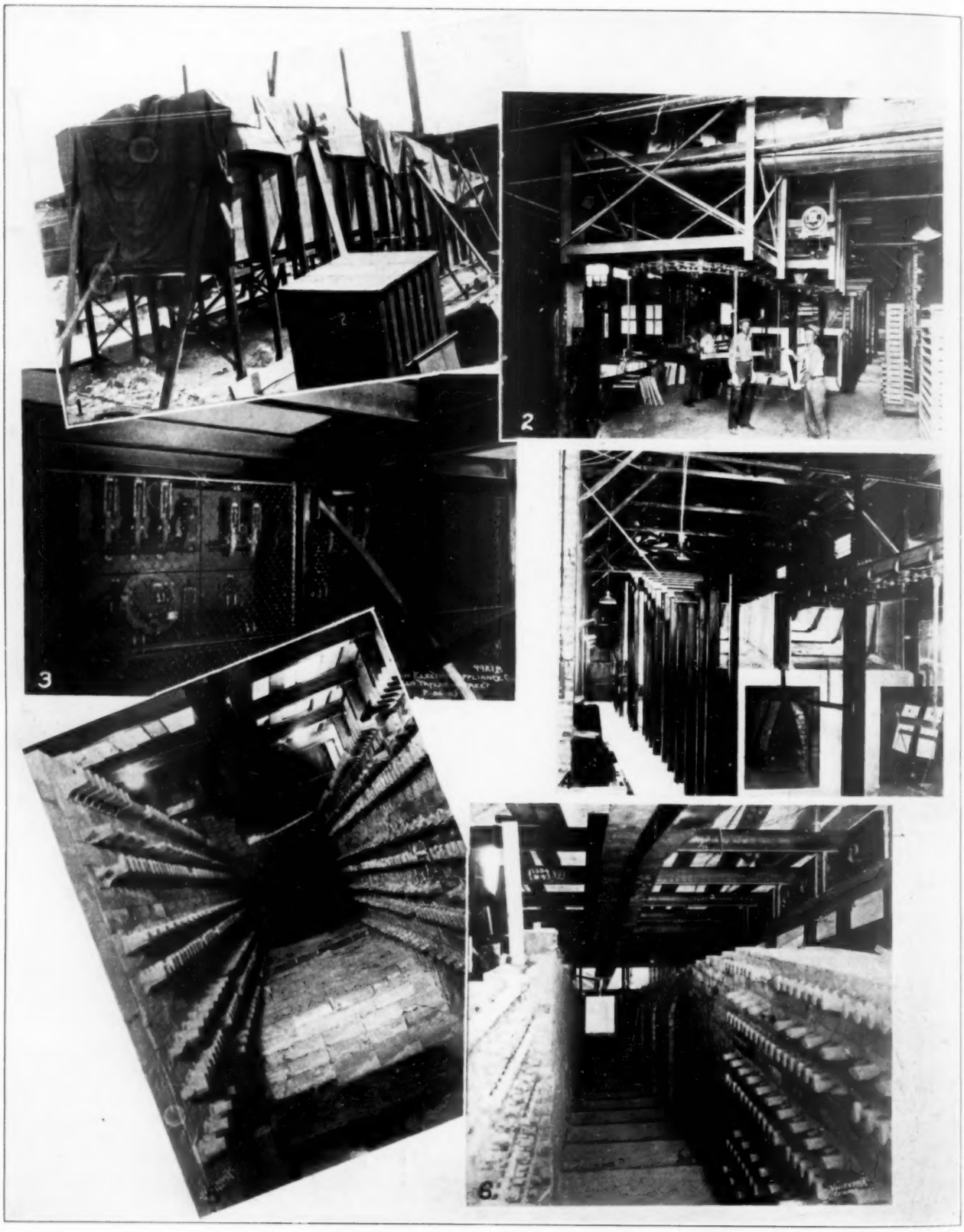
The shell of the furnace extension is of 14-gage sheet metal inside and out, with insulation between the sheets. The sides of the furnace proper are of boiler plate, with insulation inside. All sheets and plates are welded.

Other Welded Equipment

Besides these two burning furnaces, all other equipment used in the enameling operations show a great degree of welded construction. These include the pickling tanks, drying ovens and their conveyors, spray chambers, and inspection conveyor.

Of the six pickling tanks, shown in Fig. 8, the acid bath is of brick construction, and the other five are of boiler plate with angle-iron frames, all welded.

The two drying chambers are located above the factory floor, and each has its own conveyor. The supports for



Views of Original Furnace During and After Construction

Fig. 1. The Furnace First Was Completely Erected and Then the Building Extended Over It.

Fig. 2. The Conveyor and Racks Are All-Welded and Are Supported From a Welded Overhead Frame. The Furnace Is in the Rear.

Fig. 3. Electric Control Panels Under Rear of Furnace. The Frame of the Wire Guard Is Welded, as Are Also the Overhead Beams.

Fig. 4. The Welded Uprights and Cross Beams Are Spaced Along the Entire Length of the Furnace.

Fig. 5. View of Half of the Burning Chamber, Looking Toward the Return Bend. The Roof Insulation Has Not Yet Been Applied.

Fig. 6. Locking Toward the Open End From the Burning Chamber. The Archways in the Middle Wall Connect with Both Legs of the Furnace.

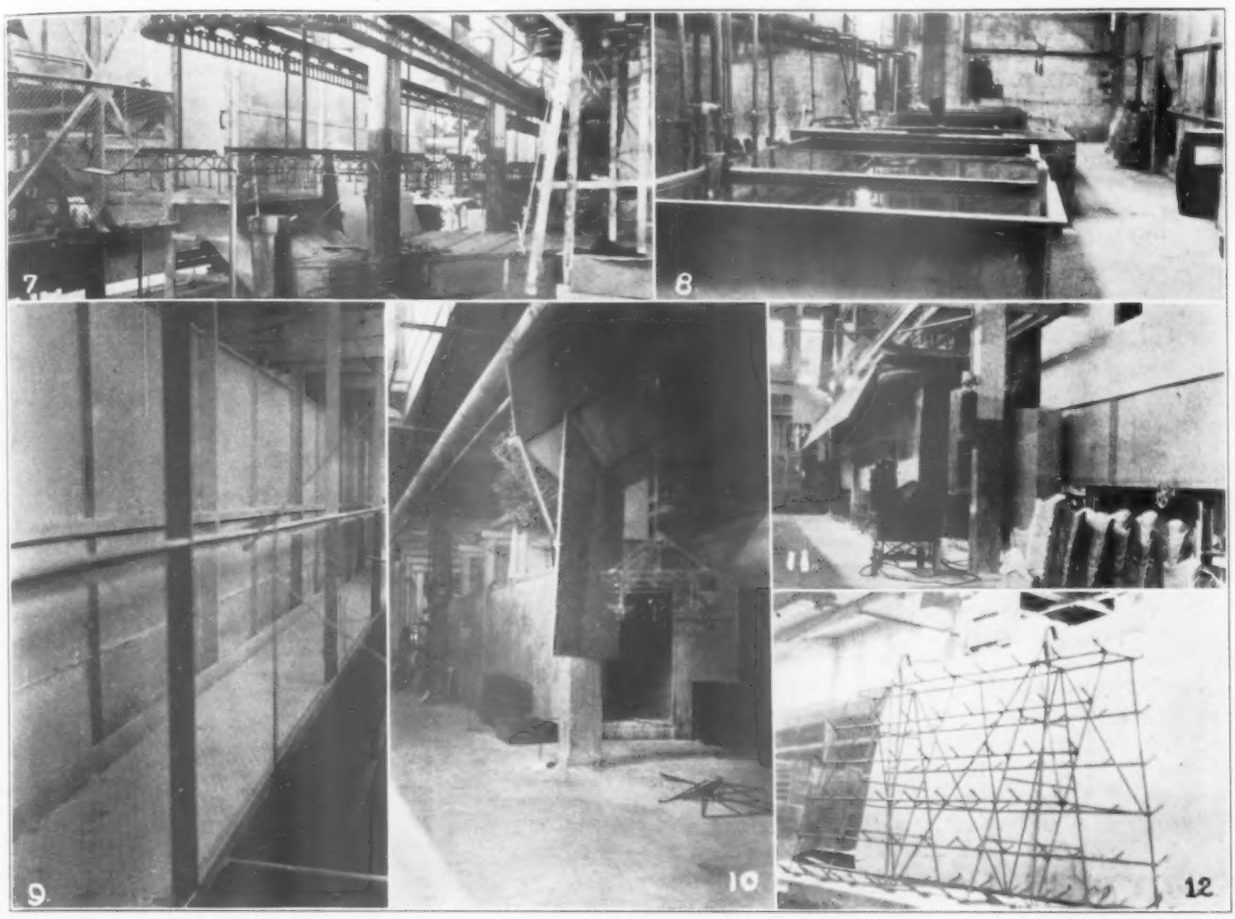


Fig. 7. Conveyor for Burning Furnace. In the Rear Is an All-Welded Spraying Chamber, with Exhaust Ducts Underneath.

Fig. 8. Pickling Tanks Constructed of Welded Mild-Steel Sheets and Angles, Except One Built of Brick.

Fig. 9. View of Part of Welded Drying Oven, Showing Walkway.

Fig. 10. The New Furnace Is of Similar Design to the Old, But Has a 24-Ft. Extension on the Front.

Fig. 11. On the Right Is a Spraying Chamber, Alongside of Which Are Stacks of Enameled Legs for Electric Ranges. In the Rear Is a Conveyor for One of the Burning Furnaces, and in the Extreme Left Rear the Inspection Conveyor. An Arc-Welding Machine Is Also Shown.

Fig. 12. One of Several Types of Oxy-Acetylene-Welded Nichrome Racks for Holding Material Being Conveyed Through the Burning Furnace.

these chambers are of welded angles and I-beams, and the oven part is of sheet metal welded to angles and channels, which also are welded and covered with insulating material. The walkway running the length of one side of each chamber, shown in Fig. 9, consists of diamond steel plate tack welded to a frame which in turn is welded to the chamber supports.

The conveyor of each drying chamber has an I-beam track with angles welded to it for support from the ceiling. Each of these two conveyors leads to a separate spraying chamber, the spray bath and exhaust ducts of which are built of sheet metal with welded seams. The inspection conveyor is of the apron type with a welded frame of channel iron.

Progress of Material Through Enameling Department

The part to be enameled is first subjected to the pickling bath, then dried, and then dipped to give it the ground coat. It is then hung onto a conveyor which carries it through one of the overhead drying chambers; then it is transferred by hand onto one of the U-type-furnace conveyors, and in its passage through the high-temperature furnace the ground coat is burnt onto the metal base. The next operation is to remove the part from this conveyor after its passage through the furnace, and to transfer it to a spraying conveyor. It is sprayed white in one of the spraying chambers, and the same conveyor then takes it into the other overhead drying chamber, after which any loose enamel is brushed off. It again goes through the U-type burning furnace, and then the cycle of spraying, drying, and brushing is gone through once more. Then the final inspection is given the part as it travels along on the inspection conveyor.

Where other colors are to be added, more operations are required than outlined above.

The furnaces and all the other equipment described were designed and erected by the plant force, under the supervision of E. M. Shaw, superintendent in charge of maintenance and construction work. Welded construction was found to be adaptable to all requirements, and at many points it simplified the design and made it more flexible. Moreover, the completed equipment represented a considerable saving in cost over other methods of construction or contract cost. For most equipment, the cost of erection by the shop force, using welding, was not more than half the cost figures submitted by contractors.

The complications of the carrier systems were easily mastered by welding. The overhead I-beam tracks for the conveyor rollers were readily cut to size, heated with the torch and bent to any angle desired, and then welded against the end of the adjacent section and to the overhead angle-iron supports. This construction also facilitates the making of changes in the conveyor route, and its advantage was particularly apparent when a change-over was made necessary by the construction of the new furnace.

When the new furnace was built alongside its prototype, it was necessary to erect the new conveyor on that side of the old conveyor opposite from the new furnace. A cross-over of the conveyors was out of the question, so at this place it was necessary to change the conveyor tracks so the new furnace used the old track and the old furnace the new track. The change-over was quickly accomplished by

breaking and reassembling the chain links at this point and cutting out the short sections of track involved and welding in new sections already cut and bent to the proper shape.

Welded Racks Subjected to Severe Service

Several different types of nichrome racks are used on these conveyors to accommodate the various kinds of parts to be enameled. These racks can quickly be removed and new ones hung into place whenever the production schedule requires a change from one type of enameled part to another. These racks, some of which are seen in Figs. 2, 4, 7, and 10, must withstand the high heat of the burning furnaces; hence they are made of nichrome, a nickel-chromium alloy with high heat-resisting properties, which is used extensively in the making of electric heating elements. These racks are constructed of pieces of nichrome wire welded together with the oxy-acetylene torch, this being the only construction in which arc welding is not employed. A special nichrome welding rod is used, and the torch flame must be adjusted carefully to obtain satisfactory results. The rack shown in Fig. 12 is particularly interesting as an example of welded design. All these welded racks have withstood the continual alternate heating and cooling of the burning cycle with no ill effects whatever.

Welded jigs are used in the manufacture of all these racks. Trucks and other equipment made in quantity for shop use are also assembled and welded in special jigs built by welding. The advantages of welding have been so thoroughly demonstrated in these furnaces and conveyors that much of the other equipment used in the "Hotpoint" plant has been constructed by welding.

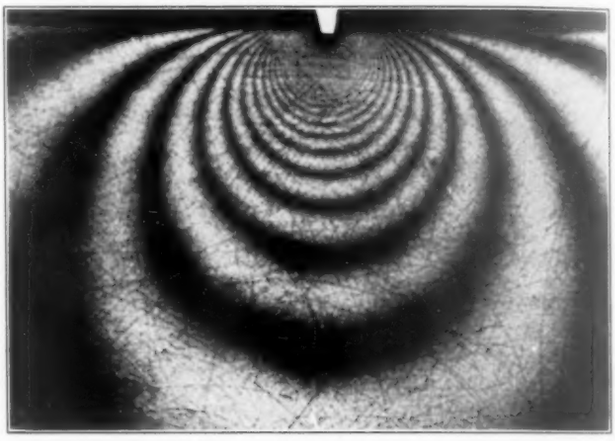
WHAT OCCURS WHEN STEEL IS DEFORMED

The physical action that takes place within steel or other metal when it is deformed through loading is being investigated by A. Nadai, of the Westinghouse research laboratories, who presented a paper on this subject before the 12th annual meeting of the American Society of Heat Treating, recently held in Chicago, Ill.

A number of cases of concentrated loads are being studied by means of two different methods. One method consists of photo-elastic tests with a perfectly elastic and transparent material, in which special attention is paid to so-called isochromatic lines, which it is believed should tell exactly how stresses in a piece of steel are distributed. The accompanying illustration shows isochromatic lines viewed through an instrument known as an "optical bench," by which the slightest deformation in a ductile metal can be observed.

The second method consists of deformation tests with the steel itself, in which special attention is paid to the so-called slip lines which are visible in the deformed piece.

This study was undertaken with the view of determining what actually takes place in the severely compressed steel while passing through the rolls in the mill, and gives promise of reducing the amount of power required and increasing the quality of the finished product.



"Isochromatic Lines" Observed Through the "Optical Bench." They Show a Piece of Steel Under a Concentrated Load.

"Because of the close connection between the isochromatic and the slip lines," said Dr. Nadai, in the paper referred to, "it is now possible to make visible before the actual rolling those weak surfaces in a severely compressed steel piece along which the steel will yield during rolling or during some other plastic deformation."

OIL-REFINERY RUNDOWN TANKS WITH WELDED SEAMS

The application of welding in oil refineries has extended to the welding of the vertical seams in shallow rundown tanks. The illustration shows a group of such tanks, which were designed and erected by the Chicago Bridge & Iron Works, Chicago, Ill. This company also uses a great deal of welding in the fabrication of tank roofs and bottoms.

In the welding of the vertical seams of the tanks shown, the seams first were laid up by means of bolts spaced about 15 in. apart, then tack welds placed 8 or 9 in. apart, after which the seams were welded from the bottom up.

ROADBED AND SIDEWALK FRAMEWORK JOINED TO BRIDGE BY WELDING

On the new Wabash Avenue bridge being constructed over the Chicago River just outside Chicago's "loop" district, the usual old-style plank between the bridge framework and the roadbed was done away with because of high maintenance cost, and a special steel construction was substituted. The pavement and sidewalk consisted of large slabs of Haydite—a light-weight monolithic aggregate—laid with their edges together. Each slab was poured around an angle-iron frame, and the slab and frame set in place on the superstructure of the bridge.

Riveted onto the angle-iron frame were from 14 to 30 plates, the number depending on the size of the frame or

Welder at Work on the New Wabash Ave. Bridge in Chicago.

concrete slab. These plates were cut from ⅜-in. steel and were 6½ in. wide at the top and 3¼ in. at the bottom, somewhat resembling a keystone in their shape, with the nose of each plate extending 6½ in. below the bottom of the slab and resting on the I-beam joists of the bridge structure.

The bottom edge of each plate is welded to the I-beams on which the plate rests by means of ⅜-in. fillet welds deposited on both sides of the plate. A total of more than 4,800 such plates were used on the roadway and 1,680 plates on the sidewalks.

The welds in this construction are subjected to severe service owing to the vibrations set up by street cars and other types of traffic using the bridge. Moreover, this bridge is of the bascule type, and when a leaf is lifted the welds must stand the strain of holding the heavy 5¾-in. concrete slabs in place.

A similar type of construction was used for the sidewalk slabs in the Clark Street bascule bridge put into service by the city of Chicago in September of last year. The reliability of this construction, together with its lower first cost and elimination of maintenance expense, was demonstrated in this case, which led to the adoption of this construction for both the roadway and the sidewalks on the new Wabash Avenue bridge.

In the erection of the bridge over the Calumet River at 106th Street, in Chicago, which was opened to service in July, 1929, a construction was employed somewhat similar to that described above, except that I-beams were used in place of plates riveted to the concrete-slab frames. These I-beams likewise were welded onto the I-beam joists of the roadbed.

WELDING METHOD PROVES IDEAL FOR STRENGTHENING BUILDING BEAMS

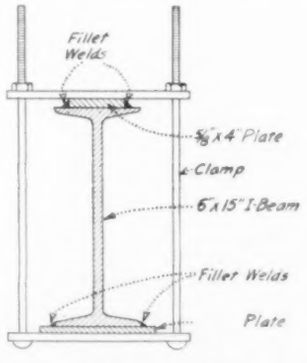
A 3-story building that has been undergoing remodeling in Evanston, Ill., presented the problem of how best to add strength to the existing steel I-beams to take care of increased loads. The beams to be strengthened were supported between the building columns, and the wooden floor joists were framed into them.

Replacing the beams with heavier sections would have involved a prohibitive cost. Hence it was decided to strengthen the beams by employing plates along the top and bottom flanges. The riveting of these plates would have meant the spacing and drilling of holes and the countersinking of the rivet heads in the upper plate, as the requirements were such that rivet heads could not extend above the top plate. The alternative was welding the plates in place.

The successful bidder for the job was a local welding concern, the Manz Welding & Boiler Co., at 1711 Maple Ave., whose bid specified the arc welding of the plates. As the building code in force in Evanston does not recognize the use of welding in structural-steel work, it was necessary to satisfy the local board of building commissioners that the design was correct and that the welds would be of the required strength. The latter point necessitated that the welders have samples of their work tested by a reputable laboratory. The test results were far above the minimum requirements set by the building commissioners.

Twelve beams in all were strengthened by the welding on of plates. The length of plates used and the amount of welding varied somewhat with the length of the beam and the load it had to carry. The width of the upper plate was such as to allow the upper flange of the beam to extend out about an inch on each side of the plate. The lower plate was made wider than the beam flange, so the weld beads could be deposited from the upper side, as the sectional drawing shows, thus saving the construction of scaffolding and eliminating the need for overhead welding.

The plates were held rigidly in place by clamps, one of which is shown in the drawing. Fillet welds were deposited



Illustrating Method of Clamping and Welding Reinforcement Plates to I-Beam.

at certain points along the edges of the upper plate, these welds being staggered with respect to the two edges. The welds on the bottom plate likewise were staggered, but this was made necessary to avoid the wooden joists; these welds were deposited along the edges of the lower flange of the beam. All welds were ⅜-in. fillet, 2 in. long.

A typical construction is a beam 18 ft. long, with a flange width of 6 in. and a depth of 15 in. The upper plate is of ⅝-in. material, 4 in. wide and 10 ft. 6 in. long, and is welded to the I-beam by means of 16 fillet welds staggered along the edges of the plate. The lower plate is of ⅜-in. material, 8 in. wide and 10 ft. 6 in. long, and is welded to the beam by means of 16 fillet welds staggered along the edges of the lower flange of the beam.

Each beam required, as an average, about 2 hours for welding complete. Before starting to deposit the bead, the

welder each time had to burn the paint off the I-beam at the spot to be welded.

The rules of the local iron workers union required that two of their members be employed on the job during the time of welding, although their duties were not specified. Hence, one union man was employed to do all the work incidental to the welding operations, such as handling of the reinforcing plates, mounting and adjusting the clamps to hold the plates in place, moving the welding cables as the work progressed, etc., thus leaving the welder to do nothing but weld. The other man stayed on the floor below with a pail of water handy, as a precaution against fires that might be started by the falling sparks from the welding arc.

Although welding is often employed, with savings in both time and expense, where buildings are to be remodeled, and a number of such jobs have been described from time to time, the case of the Evanston building is particularly interesting inasmuch as it was the first time welding had been employed in structural-steel work in that city, making it necessary that the successful bidder satisfy the building commissioners of the competency of the welding method. Moreover, the work started out with the handicap of having to hire two additional men whose duties took up but a small fraction of the total part of the working day; yet despite this handicap, the contractor bore this additional cost and accepted the bid of the welding firm.

BRITISH RESEARCH COMMITTEE REPORTS ON WELDED GAS CONTAINERS

By A. C. Blackall

The Gas Cylinders Research Committee of the British Board of Trade's Scientific and Industrial Research Department recently reported on welded containers. The committee, which is under the chairmanship of Sir Harold Carpenter, and includes Professor Boys, Professor Lea, and Sir Thomas Stanton, in addition to representatives of the Home Office and the Board of Trade, made a number of important recommendations by which the use of welded containers, if allowed at all, should be controlled. It recognizes, however, that no official recommendation can entirely eliminate the risk involved when vessels of large capacity are used for gases of a poisonous character, such as chlorine, phosgene, sulphur dioxide, and ammonia gases, to which the present report refers. The purpose of the report is, therefore, to define the best conditions that scientific experience can suggest in regard to the construction of the vessels and other matters relating to the conduct of the trade. Whether, and if so, how far, the use of such vessels should be circumscribed by regulations is left for attention by the appropriate administrative department.

While in the past lap-welded containers were used for the transporting of gases at internal pressures as high as 1,800 lb. per sq. in., it is now held that solid-drawn cylinders are more reliable. Above a certain diameter, however, steel tubes become far more difficult and costly to draw and to close, and when liquefied gases are required in large quantities the limitation of the maximum size in which solid-drawn cylinders can be produced may involve greatly increased charges for handling. Accordingly, during the war larger vessels of two general types were introduced for conveying liquid chlorine. One, orginally with a chlorine capacity of about 15 to 16 cwt., was in the form of a cylinder about 30 in. in diameter and 6 ft. long, made of a bent steel plate welded longitudinally and closed at each end by a concave dished cap welded to the cylinder. Other drums of the same kind have since been made with chlorine capacities of from 560 to 2,240 lb. The second type of vessel has a capacity of about 13½ tons of liquid chlorine, contained in a cylinder of similar construction to the first and carried on a special form of freight car. The maximum pressure at which these cylinders have to work vary in temperate climates from 60 lb. per sq. in. for phosgene to 278 lb. for ammonia, and in tropical climates from 120 lb. to 516 lb., the assumed maximum temperatures being, respectively, 50 and 75 deg. C.

On the assumption of these maximum temperatures, provision has to be made in use to ensure that, despite the thermal expansion of the liquid gases, some space is left containing free gas, and allowances varying from about 4% to 6% are specified for that purpose. As yet no systematic research has been pursued to determine the composition and mechanical properties of steel by which the best welding quality is obtained—a matter naturally of the first consequence in constructing these cylinders. A large amount of experience, however, is available in America and Britain, giving concordant results as to the most suitable compositions, and on the strength of these a proposed specification has been framed. A consideration of previous results and formulas has also enabled the dimensions of cylinders and the form of the end-plates to be defined. A large number of tests, carried out partly by railway companies and partly at the National Physical Laboratory, Teddington, enabled a comparison to be made between the results of welding by water gas, electrical heating, and oxy-acetylene flame, and investigations were also made on the values of various alternative mechanical tests, including a drop test to be applied to random samples out of a batch.

The recommendations in the report include analytical limits of composition for the mild steel to be employed, which may be made by either the acid or the basic open-hearth process and must fulfill defined tensile-elongation and cold-bending tests. The method of welding must be such as not to heat the material to a higher temperature than is required in order to obtain a satisfactory joint. The welding must be carried out while the metal is in a plastic and not a fused condition, and must be accompanied by a sufficient amount of mechanical work, continued until, but not after, the material has cooled to about 800 deg. C. Other recommendations are given as to overlap, the fixing of the ends of drums, and inspection, together with formulas by which the dimensions of containers and the thicknesses of their walls and end-plates are to be determined. The completed containers are to be brought to a temperature of about 950 deg. C. in a furnace and then immediately withdrawn and normalized. It will be seen that the conditions of welding indicate the use of water-gas heating.

The routine test to be applied to the completed containers includes a hydraulic test to a definite pressure, and for drums also a test on at least 1% of each batch. The tests carried out during the investigation of the committee, however, proved that satisfactory welds require high ductility and high Izod impact figures. It is on the result of these tests that the superiority of the water-gas welds was shown. In the tests, however, there was evidence in the majority of cases that the material had been overheated. Consequently brittleness was created in the weld.

OXYGEN-PRODUCING PLANT DESCRIBED

The October issue of *Byllesby Management*, published by the Byllesby Engineering & Management Corp., carries an interesting article describing the oxygen-producing plant which has been operated since 1920 at Fort Smith, Ark., by the Mo-Arc Oxygen Co. The article gives an interesting history of this company and its growth, and the illustrations include photographs and a diagram of the air-liquefaction oxygen equipment used by the company. It is stated that at present this company is manufacturing daily about 500 cylinders each of hydrogen and oxygen and that they recently closed a contract with the United States government to supply 20,000 cylinders of hydrogen.

Applications of Bronze-Welding*

Bronze-Welding, With Correct Procedure, Is Being Used More and More in the Repairing of the More Common Metals and in Production Work

AS RECENTLY as eight years ago bronze-welding was little known outside of a very few large industries. Today practically all commercial metals are being bronze-welded, the size of the work imposing no limitation on the use of this process. It is even interesting to compare the work being done by this method only three years ago with the tremendous variety of work being done today.

Bronze-welding should not be confused with brazing, although the process is somewhat similar. Brazing, which metal workers have employed for a long time, consists in heating the metal parts to be joined hot enough to melt a brass alloy called "spelter," usually supplied in powder or chip form, so that it flows into the fluxed joint. The use of the oxy-acetylene flame to accomplish brazing led to the development of the modern art of bronze-welding. In bronze-welding, the bronze is supplied in the form of welding rod and the oxy-acetylene flame serves to heat the base metal to the proper temperature as well as to melt the welding rod. The operator is thus enabled to control the work accurately at all times. Although not a fusion weld, in many cases a bronze-weld made with a high grade bronze-welding rod and good flux produces a joint comparable in strength and reliability to a fusion weld.

Bronze-welding is extensively used today both in repair and production operations. It is used in three general ways: for producing joints in metals with a higher melting point than bronze, which includes nearly all commercial metals; for building up worn surfaces, and for making fusion welds in bronze itself.

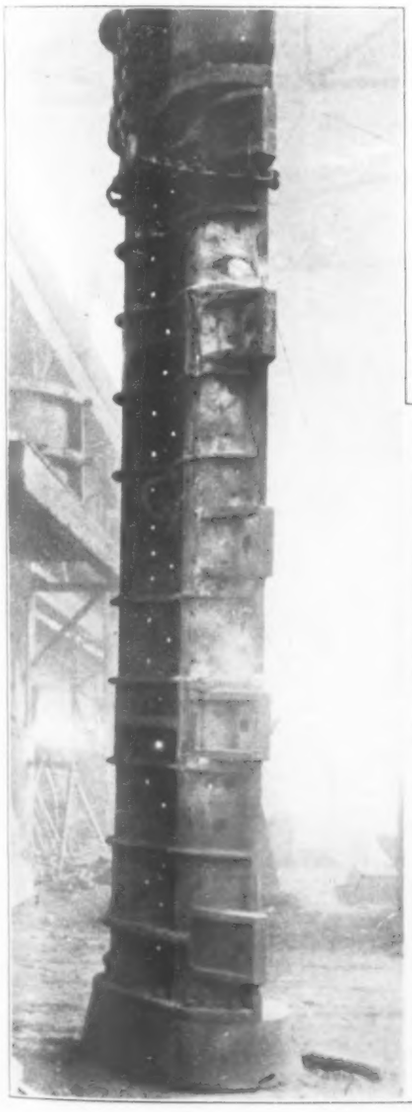
Cast-Iron Repairs

The bronze-welded joint made in cast iron is the most familiar application of this process, and the joint can be quickly made with the application of very little heat, general preheating in a furnace seldom being necessary. Some preheating may be required for large castings, but it is usually possible to arrange some means of supplying the heat locally, as only the parts in the immediate vicinity of the break need to be heated. Hence large castings may be welded in their operating positions without dismantling. Frequently the entire cost of a bronze-welded repair is far less than just the labor cost of dismantling the machine to permit repair by any other method.

For small castings, the welding blowpipe itself is used as a convenient means of preheating the part before welding.

Cast iron should be prepared for bronze-welding by chipping or grinding the surfaces to be joined to form a vee, and cleaning them thoroughly after grinding so that the bronze will have a clean surface to which to adhere. After the parts are aligned in the correct positions, the blowpipe flame should be played on the metal surrounding the break so that it is heated gradually to the point where it begins

*Reprinted from *Oxy-Acetylene Tips*, November, 1930.



(Left)—Crack 6 Ft. Long in Large Cast-Iron - Pipe Foundry Flask Repaired by Bronze-Welding.

(Below) — Bronze-Welding a Cast-Iron Limestone Crusher Located in a Cement Plant.

to glow. If the cast iron is to be preheated, it should be heated only to a black heat, which is the point just below that of the dull red required for bronze-welding. A casting hot enough to char a crumpled newspaper or sawdust is ready to weld with bronze. However, the surface being welded must be brought by the blowpipe to the proper temperature, for if it is too hot the bronze will boil and run off like mercury and if it is not hot enough the bronze will not adhere.

The use of a high-strength bronze-welding rod and suitable flux is essential to successful bronze-welding. While the metal of the casting is being heated by the blowpipe flame the end of the bronze rod should be heated and the hot end dipped in the can of flux so that sufficient flux will adhere to the rod. The end of the fluxed rod should be melted onto the heated spot. With the metal at the proper temperature, the molten bronze will flow in a thin layer and spread out over the metal ahead of the main deposit to produce the tinning coating. Proper tinning is a vitally important factor in the technique for bronze-welding cast iron. After the tinning layer has been obtained, more rod can be added rapidly and the vee quickly built up. A section of the metal about 2 in. along the vee is heated and the weld made in the above manner, first tinning, then building up. The next increment is then made. Fluxing should be continued throughout the operation so that any impurities or bubbles of gas in the weld metal will be removed. As in all ripple welding a swinging motion with the blowpipe is used, care being taken that the inner cone of the blowpipe flame is kept between ⅛ and ¼ in. away from the surface of the puddle.

It is advantageous for a bronze-weld to cool slowly, and in the case of a large casting a sheet of asbestos paper is often used to cover the finished job and protect it from drafts during the cooling. No stress should be placed on a bronze-welded joint until it has completely cooled. The finished weld may be cleaned with a wire brush to remove any excess flux or impurities which may have risen to the surface.

Application to Cylinder Blocks

The bronze-welding of cast iron has been a standard practice in the field of automotive repair. Cast-iron cylinder blocks are regularly repaired by bronze-welding, using the oxy-acetylene flame. Nearly all automobile repair shops today are familiar with the practice of bronze-welding cast iron. An automobile cylinder block may be bronze-welded in place, although it is recommended that if convenient the block be removed and placed in a position in which it may be most easily welded. If the block is left in the car, all other parts of the machinery must be protected from the heat of the oxy-acetylene flame, and all gasoline thoroughly drained.

A variety of types of cracks occur in cylinder blocks. Often the crack is in the water jacket in the head, in the cylinder wall, in the corners of the block, or in the cast iron arm. The water-circulation system should be drained below the level of the crack and the cooling system vented so that no pressure will be built up from the heat. Some shops make a practice of running the motor for a few minutes with the cooling system drained so that the casting will be preheated to a certain extent. As in all cases of the bronze-welding of cast iron, the crack should be chipped out throughout its entire length and slightly beyond the extremes of both ends, where the crack may not be evident on the surface of the metal. The same general rules for bronze-welding apply in repairing cylinder blocks as in other cast-iron repairs. Where a piece of the cast iron is completely broken out of the block, it should be tack-welded in place with the bronze-welding rod before the final bronze-welding is accomplished.

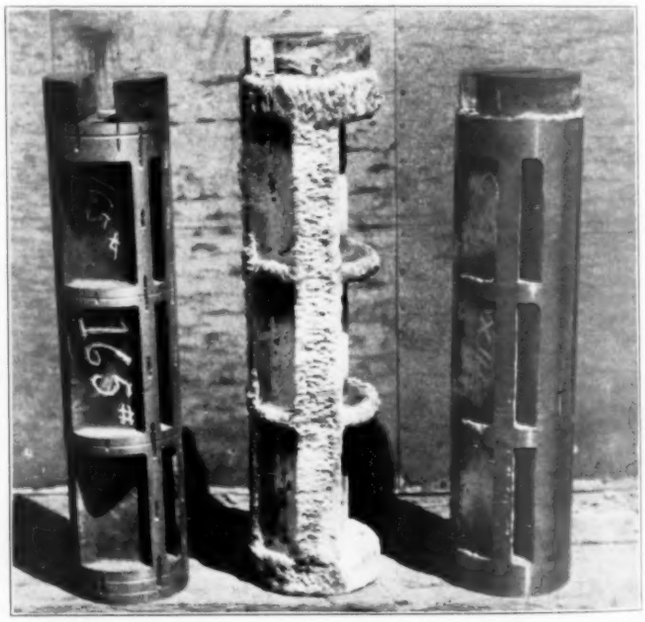
Within the last two years the bronze-welding of cast iron has been extended to pieces of machinery of tremendous size, many of which would formerly have been considered unweldable. Large presses which often become fractured through overloading are regularly repaired by bronze-welding. Rock crushers or limestone crushers used in rock-products and cement plants have been among the more recent bronze-welding repairs made by the oxy-acetylene process.

When bronze-welding repairs of this size are being made it is frequently necessary to have gas-torch preheating flames constantly playing on the casting in order to maintain the proper heat. In jobs of this size repairs would be practically impossible were it not for bronze-welding, as the difficulties of preheating castings of this size in a furnace would be tremendous.

Welding Large-Size Castings Without Dismantling

Huge cast-iron power shears used for cutting steel billets have had the side frames cracked under the strain and have been restored to service by bronze-welding. Repairs to Diesel-engine frames by means of bronze-welding are also becoming common. In one case a cracked Diesel-engine frame was repaired in a tug without removing any of the parts from the ship, the welding being accomplished below the water line of the tug; if bronze-welding had not been employed a complete dismantling of the engine would have been required. Many castings of unusual size, such as are used on underground pumps in mines, have been saved from the scrap pile by this application. Bronze-welding has proved to be invaluable in keeping industrial-type locomotives in service.

Cast-iron foundry flasks are frequently broken, and it is only in recent years that the foundries have realized the

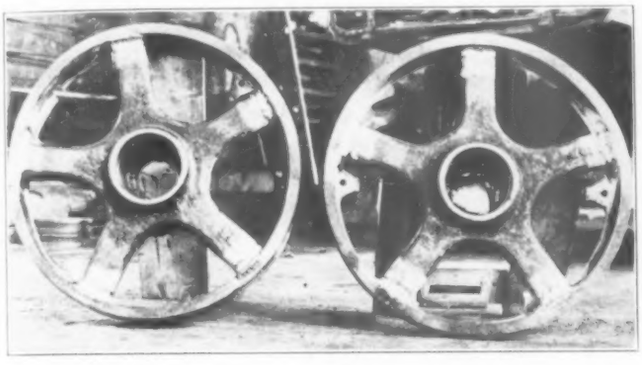


Rotary Valves on Pumping Equipment Built Up With Manganese Bronze.

tremendous savings which may be effected by reclaiming them. Formerly these flasks were scrapped and the metal remelted, but today the speed and economy of bronze-welding have led to its use by a great number of foundries. These flasks receive particularly hard service and, after each pouring, the mold is frequently dropped several feet to clean it, so breakage is quite frequent. Intricately shaped flasks for thin castings are particularly valuable and worth reclaiming. Foundry welding departments are called upon to bronze-weld long seams and also patches. Sometimes these cracks extend for 6 ft. or more. In small flasks break-

age occurs frequently by enlargement of the hole. These holes are now filled with bronze and redrilled. A bronze bushing of this type will never work loose. The savings which foundries have effected by this means of reclamation are enormous.

During this year an increasing number of water lines have been constructed of cast-iron pipe with bronze-welded joints. The bronze-welded joint of the new improved shear-vee type, made under procedure-control methods, is free from leakage and future maintenance expense. Municipal water departments in all parts of the country are realizing the value of this application. Furthermore, the standard 12-ft. lengths of cast-iron pipe are double-lengthed into 24-ft. sections at the foundry by bronze-welding before they are shipped to the job. This practice is recommended because it reduces the number of field joints to be made and facilitates transportation. In certain cases, cast-iron pipe has been triple-lengthed at the foundry and shipped in 36-ft. sections. When aligning the pipe for welding, the



New Steel Rims Bronze-Welded to Cast-Iron Truck-Wheel Spokes.

joint should be tack-welded in three places, and, when the actual welding is being done, the puddle should be started and maintained near the top quarter of the circumference, which requires that the pipe be rotated during welding. It may well be emphasized again that the bronze-welding of cast-iron pipe should be done only in accordance with procedure control.

Making Strong Joints in Malleable Iron

Bronze-welding is the only successful method of making strong joints in malleable-iron castings. If malleable iron is melted, its malleable properties are completely destroyed; and it is almost impossible for the user to restore them, as they are the result of a special heat treatment, the facilities for which are available only at iron foundries and at special shops. The changes brought about in this metal by fusion practically require that a method of joining be employed which does not involve bringing the base metal to the melting point. The comparatively low temperature required for bronze-welding has no harmful effect on malleable castings, and this method is therefore employed for making welds in this metal. Malleable castings are usually small in size and seldom require preheating. The technique for bronze-welding this metal is the same as that for bronze-welding cast iron. A great deal of money is saved annually by textile mills and other industries using a large number of malleable castings, through reclamation by bronze-welding.

Welding Steel and Wrought Iron With Bronze

The technique for bronze-welding steel or wrought iron is similar to that for making joints in cast iron. The metal should be heated by the blowpipe to a dull-red heat before the bronze is flowed onto the joint. Bronze-welding is frequently found advantageous in production operations for making joints in steel where the strength of a fusion weld using steel welding rod is not required and where the color of the joint is immaterial. The production of metal furniture provides an outstanding example of the use of bronze-welding in joining steel. Bronze-welding may be accomplished with much greater speed than steel welding, with a consequent saving in oxygen and acetylene. Another factor in favor of bronze-welding on light sheet steel is that there is less opportunity for warpage, because less heat is required. In fact, bronze-welding is nearly always employed in the production of metal furniture, except where a vitreous enamel is required, and in that case a steel weld is used in order to withstand the enameling temperature.

Bronze-welding is used on wrought iron in ornamental iron work. With this process the metal artist need not bring the iron to the melting point. The bronze will flow between tight-fitting metal parts, and the temperature required is not high enough to mar any sharp edges. In some cases of this type a fusion weld in the wrought iron would be impossible without warping or completely melting the objects being welded.

Galvanized Iron

The welding of galvanized iron presents somewhat of a problem owing to the fact that the coating of zinc which forms the galvanizing has a relatively low melting point and also has the property of volatilizing when heated. When the galvanized material is heated, the zinc coating does not melt and run on the surface, but vaporizes and burns, forming zinc-oxide fumes. When a fusion weld using steel welding rod is attempted on galvanized iron, the galvanized coating is usually burned for about an inch on each side of the weld, so that it may be necessary to apply a protective coating over the section near the weld after the joint is made. The low melting point of high-strength bronze-welding rod allows the joint to be made at a low-enough temperature that the galvanizing on each side of the weld is not entirely removed. Galvanized iron pipe, frequently used for water and other industrial services, may best be bronze-welded, and the completed weld will require no coating of paint or other protective material afterwards. Many manufacturers of large storage tanks made of galvanized iron have adopted bronze-welding as a regular production process, as they have found it the most economical way of obtaining a satisfactory joint.

Bronze-Welding of Copper

For a number of years, very little welding was done on copper. In order to obtain successful fusion welds in this metal it was necessary to have specially deoxidized copper sheets and to use a copper rod with a sufficient amount of silicon to insure complete freedom from oxide. Although it is now possible to obtain copper stock specially deoxidized with silicon for welding, a greater part of copper joining consists in work on ordinary commercial copper. For such work it has been found that bronze-welding will produce a strong, tight joint free from corrosion.

The technique for bronze-welding copper pipe, castings, or sheets is the same as for bronze-welding the ferrous metals. In the case of copper, however, care must be taken to use as little heat as necessary on the base metal as copper has a high rate of thermal conductivity so the heat is soon dissipated through the surrounding metal. Bronze-welding must therefore be accomplished quickly and the copper should not be heated any farther back from the weld than is absolutely necessary. Copper castings and material over ⅛ in. thick should have the edges beveled for welding. Proper tinning is as important to the bronze-welding of copper as it is in the case of cast iron or steel. The parts to be joined should be heated to a temperature which will show a red heat in daylight, which is the point at which the bronze will unite to the base metal.

This application is particularly useful in the fabrication

of chemical containers of copper and also in the manufacture of water pipes and hot-water heating coils. Copper sheet, pipe, and castings are being used to a greater extent today than ever before in a number of industries; and the old-fashioned mechanical joint—folded and grooved, riveted, or screw-coupled—has been inadequate where strength and tightness are desired. The fact that bronze-welding is able to produce joints capable of satisfying the demand of these industries for tight joints in commercial copper has led to a wide-spread use of this application.

Application to Brass and Bronze

Brass water piping in buildings has been the chief application of the bronze-welding of this metal. When brass is melted the metal boils and bubbles at the surface and gives off zinc-oxide fumes, indicating a loss of zinc with a consequent change in the character of the metal near the weld. It is therefore advantageous to use a bronze-welding rod with a low melting point to produce a bronze-weld in this metal. Many large buildings recently have had complete water-piping systems installed of brass with bronze-welded joints.

Bronze-welding is frequently employed to make fusion welds in bronze castings. In these cases the castings are usually preheated completely and the heat retained by an asbestos covering during the welding. By using a high-strength bronze welding rod with a low melting point, it is necessary only to bring the base metal up to the point of fusion, which will avoid any possibility of fuming or boiling of the base metal during the welding.

Building Up Worn Surfaces

Bronze-welding is being used effectively as a method of building up wearing surfaces. When the part again becomes worn, more bronze may be added to the surface to restore it to normal dimensions. Where the wearing action is particularly severe, manganese-bronze welding rod is advantageously employed. Examples of this have been found in the building up of Diesel-engine pistons. When these pistons become badly worn, it would be necessary to discard both the piston and the cylinder if it were not possible to build up the piston to its right size. Bronze-welding is used to build up the pistons, which are subsequently machined down to the correct size. Oil companies build up rotary valves and machine them to fit the rebored cylinders of pumping engines. A manganese-bronze welding rod is usually employed in building up rotary valves of this type. This application is proving extremely valuable in restoring many parts of machinery.

From this brief outline it may be seen that bronze-welding is an application almost without limit. Practically all the commercial metals may be bronze-welded; even nickel and monel have been successfully bronze-welded. The progress of this application during the last year has been so rapid that there are few users of the oxy-acetylene process who do not realize the value of this operation.

Research and instruction have been two of the main factors in promoting the use of bronze-welding. The development of new bronze welding rods of higher strength and a melting point as low as 1,638 deg. F. has been an outstanding factor in advancing this application during this year. High-strength bronze-welding rod also possesses the advantage of freedom from extensive fuming during the welding.

NEW WELDED PROJECTS IN CALIFORNIA

Several important projects under construction or being contemplated in southern California will employ welding to a considerable extent.

The welding portion of a contract for the Division of Reclamation of Los Angeles and Ventura Counties, which job will consist of the welding of about 400 jetties along the banks of the Santa Clara river, was recently awarded to the National Electric Welding Co., of Huntington Park, Calif. This work, which will require several weeks, was necessitated by a disastrous flood about two years ago when the San Francisquito Dam broke, causing the loss of several lives and great property damage along the river.

A new gas-booster station is being installed in the Venice oil field by the Industrial Fuel Co., of Anaheim, Calif. The plant, which will contain three units, is being equipped with 200-hp. Cooper-Bessemer engines. Considerable welding is done in the erection of these plants, which is chiefly of the acetylene process. The installation and welding work is by the Fluor Construction Co., of Los Angeles.

Firing-Line Welding on a 22-In. Gas Line.

ALL-WELDED CROSS-COUNTRY GAS LINE

The accompanying photograph pictures a "firing line" on a new 22-in. gas line now being laid between Panhandle, Texas and Chicago, Ill. This scene—familiar to all pipe-line welders—was taken on the plains of Texas, not far from the gas fields, from which this extraordinary pipe line runs. At the time this photograph was made, over one hundred welders were employed on the line. Scenes such as this can be seen today in all sections of the country.

Training Arc-Welding Operators

The Primary Aim of the Welding School Is the Teaching of Correct Technique: First-Class Equipment and Competent Instruction Staff Are Requirements

By A. F. Davis*

THE progress of the electric-arc-welding process as a means of fabricating machine and structural designs was retarded for some time after its discovery, because of the lack of trained operators. Recently, however, with the establishment of schools designed to train men for this work, the supply of good operators has been greatly increased, and there is no necessity of delaying the change to this modern method of construction due to the absence of trained workmen.

The schools designed to teach arc welding may be divided into two general classes: (1) vocational schools, and (2) schools operated by manufacturers of welding equipment. Vocational schools, in turn, may be purely commercial enterprises, or a division of the public school system. The schools operated by manufacturers are generally maintained for the purpose of training operators for their own equipment, for customers using their equipment, or in order that a supply of operators will be available for customers.

Because of the various types of persons which will be attracted by the different classes of welding schools, the scope and purpose of the course will vary with the type of schools. One school, for example, will teach only electric welding, whereas another will teach it as part of a general course in welding. One class may contain young workmen looking for an interesting trade to follow and another may contain only men interested in learning the rudiments of welding to serve them in their executive capacities. These different points of view and experiences will govern to a great extent the conduct of the school.

Rules for Operating a Successful School

Regardless of the type of men enrolled, however, there are certain fundamental principles which must be carried out in conducting a welding school.

1. The students must be carefully chosen.
2. The workroom must be well equipped.
3. Regular hours should be observed.
4. Apparatus for testing strength and ductility should be provided.
5. Instructor should be a good teacher as well as a good welder.
6. All precautions to safeguard students should be taken.

The choice of students is a very important consideration in the training of arc-welding operators. In vocational schools this is automatically taken care of because the students generally enter of their own volition, and in commercial schools at their own expense. Thus students of these schools are generally quick to drop out if they find that arc welding is not to their liking. In schools operated by manufacturers of arc-welding equipment this is not generally the case. The students who enter manufacturers' schools are composed of employees of companies using the manufacturer's arc-welding equipment, or are prospective users recommended because of their good character and workmanship.

In general, the ideal student material composes for most part the applicants for admission to arc-welding schools operated by manufacturers of equipment. Thus it is only logical to presume that those who have completed a course from such schools are far better equipped to use the electric-arc process in industry.

Mechanical skill and intelligence are other important considerations in choosing a welding student. He should have a certain amount of natural aptitude for things mechanical, and be able to carry out directions very carefully; also have ability to learn and carry out new principles.

The welding-school workroom must be well fitted. It must have good light and ventilation, and be furnished with good and sufficient equipment. Booths should be provided for students, to protect them from the glare of the arcs of other operators.

Qualifications of Instructor

The instructor in a welding school must be a teacher as well as a good welder. Good welding ability is an absolute essential, but the instructor has lost his effectiveness if he cannot explain welding methods to his class in terms they understand. Instructions along the line of practical welding,

CERTIFICATE
OF
ARC WELDING
THIS CERTIFIES THAT
John Dambozick
Has completed the Course in Arc Welding as given by The Lincoln Electric Company, and hereby is presented this Certificate
Given at Cleveland, Ohio, this 6th day of September, 1930.
The Lincoln Electric Company

Fig. 1. Lincoln Welding-School Diploma.

with little theory, have been found to be most effective, because the primary requisites of good welding can only be obtained by constant practice.

The instructor should also have a thorough knowledge of other methods of welding and of the application of all methods to various types and kinds of metal. He will probably never have to demonstrate the other methods of welding, but he should be able to explain the advantages and disadvantages of all methods and be able to answer any questions a student might bring up. He must also be able to explain how the procedure of welding differs on various metals, as well as the application of the welding machine on metals of different make-up.

It may not be necessary or advisable to use a standard form for recording the progress of students' activities, particularly where the instructor keeps in close contact with all the students all of the time. It is usual to give a diploma or certificate to those students who complete the course to the satisfaction of the instructor.

Regular hours should be observed in the conduct of a

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welding school, just the same as in a factory. It is not necessary that the days be as long as regular plant hours, but strict hours for attendance do much to keep up the morale of the school and prepare the student for the time he will be welding throughout the day. Welding is very tiring to an inexperienced man because of the dress, unfamilar apparatus, and close attention necessary. The periods of welding in a school should be short, so as to accustom the student to welding without becoming unduly fatigued.

It is advisable to maintain apparatus for testing welds in the school. This apparatus need not be elaborate but should be sufficient to allow the student to determine wherein lie the weaknesses of his welds, and the degree of penetration he is getting. The teacher can then point out the errors and show how to correct them.

Precautions to safeguard students should be observed at all times. Each student should be provided with leather aprons and shields so that he is protected against spattering metal and the rays of the arc.

The training of arc-welding operators is an important item if the best results are to be obtained through this process.

No Perfect Student Operators

A good operator knows whether or not he is securing the correct penetration and whether or not the weld is properly placed and of the correct size and shape. A good welding inspector also knows these things almost at the instant he looks at the weld. No school can be expected to make a perfect operator of any man; but it can teach, what is more essential, the correct technique of welding. It is not only necessary to learn the correct method of striking the arc and running a good bead, but also to learn how to make various kinds of welds such as butt welds, fillet welds, vertical and overhead welds, each with the same exactness and effect.

Arc welding is rapidly coming to the front as a preferred fabricating process, and there is a constant demand for first-class operators. Manufacturers who are using this process, however, must be as careful in their selection of operator-employees as the schools have been in training them, or the benefit of this process will be lost. If an operator is well trained and honest, he can do much to advance the interests of his employer and the interests of arc welding in general by striving for perfect welds at all times, thus increasing the faith which men have in this modern process.

At the completion of the welding course, it is obviously desirable to check the student's skill by a systematic testing procedure. The students at the Lincoln Arc Welding School have an opportunity to take such a test. The examination program is based largely upon the series of tests arranged by the American Welding Society for structural operators, and since only a very small fee is made to the students for the course, an additional charge is made to those who wish to take the special test.

Special Tests for Graduate Welders

This special test is divided into three parts—A, B, and C. The first test is a single-V butt joint on two ½-in. plates, 6x8 in., welded together on the long sides so as to produce an 8x12-in. plate (Fig. 2). The plate is average structural-steel quality. The weld is made in the flat position using 3/16-in. electrode and about 200 amperes, and making the seam in two layers. The instructor watches the skill of the student in holding a short arc, in securing the proper penetration and fusion, and the use of the proper current and in using a regular movement of the electrode. The completed test plate is cut into four 2-in. coupons, which are broken in a vise in such a manner as to make sure of causing the fracture through the weld. The metal is examined for penetration, proper reinforcement, and appearance.

The second test requires the welding of a specimen in the manner indicated in Fig. 3. The material is of average structural-steel quality, and the welding is done in the flat position. No reinforcement is made on this weld but fusion is required well into the root of the weld. This weld is also made in two layers. After the weld has cooled, the specimen is torn apart by driving a suitable wedge between the plates at the unwelded end, thus bending the parts at the weld until rupture occurs at this point. The inspector checks for proper dimension of the fillet, appearance of the metal, fusion with the base metal, and the degree of penetration into the root of the weld.

The third test requires the welding of two test plates similar to Fig. 4. One of these plates is welded in a horizontal position and the other is welded in a vertical position, as in the other test. The weld is made from one side only, and is applied in two layers. From each of the two test pieces, two standard American Welding Society test coupons are cut. Each test coupon is marked with the initials of the operator and with symbols to indicate whether it was a vertical weld or a horizontal weld. Then the coupons are sent to an independent testing laboratory to be tested for tensile strength. The student is supplied with a record of the first two tests certified by the instructor and also with the laboratory report of the results of the third test.

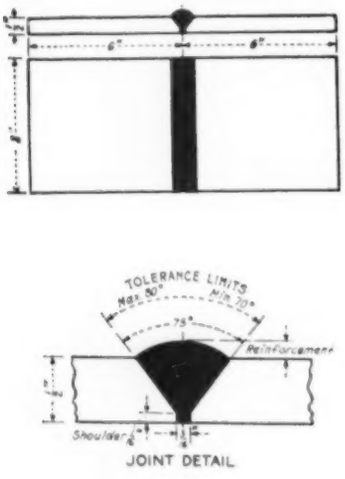


FIG. 2.

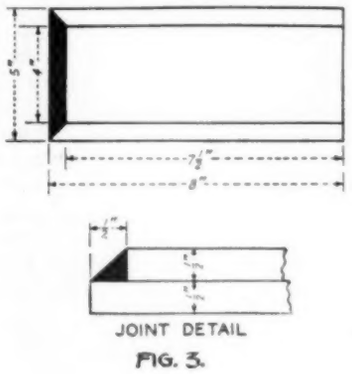


FIG. 3.

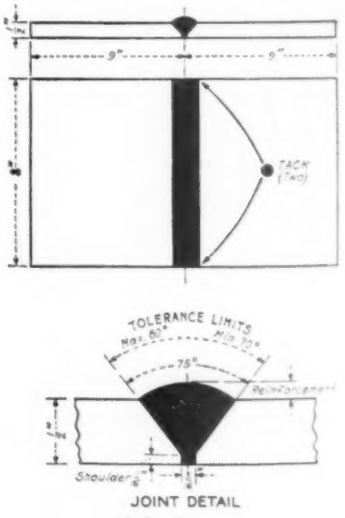


FIG. 4.

Details of Students' Test Specimens.

Fig. 1 (*Left*). Railroad Bridge That Was Strengthened With Welded Reinforcing Plates.

Fig. 2 (*Right*). Welder Applying Plates to the Top and Sides of the Top Chord of the Bridge Truss.

STRENGTHENING RAILROAD BRIDGES

By P. J. Kent

Chief Engineer, The Electric Welding Co. of America

The strengthening and reinforcing of existing steel structures is rapidly receiving recognition as an important and fertile field for the economic use of arc welding. An excellent example of this important field is illustrated in the strengthening of the Erie Railroad bridge over the Mahoning River, west of Leavittsburg, Ohio.

The contract for strengthening this bridge was awarded to The Electric Welding Co. of America, Inc., Brooklyn, N. Y., who were among the first in the field of applying arc welding to structural steel and bridge work, as well as being one of the foremost designers, manufacturers, and erectors of arc-welded products.

In planning ahead for better and more economical service for the shippers, the Erie Railroad Co. found it advisable to prepare for greater track loadings which, in the case of the above bridge, meant either the replacement or strengthening of the bridge. An analysis of the bridge and stresses

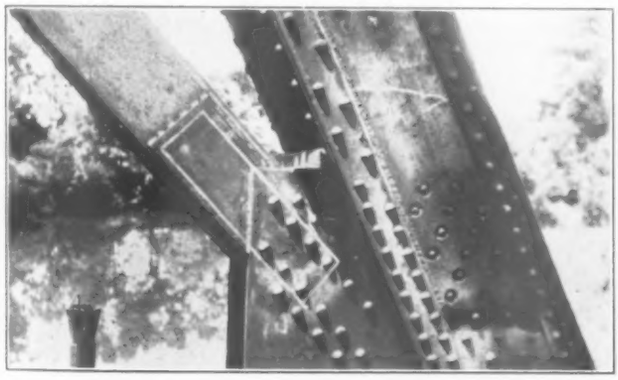


Fig. 3. Showing Welded Reinforcing Plates on End Post and Diagonal Web Member. The Area in the White Lines Is to Be Covered by a Splice Plate.

under contemplated loadings showed that the loading capacity of the bridge could be increased sufficiently to carry safely the increased loadings by the application of new steel.

A careful investigation of various methods for strengthening members of the bridge resulted in the decision to increase the section of the members which were overstressed to the required area by the addition of new steel applied by arc welding.

Some of the factors which had an important bearing on the decision to use arc welding for this work were: It was possible to perform the entire job without interruption of railroad traffic at any time and without the use of false work under the bridge; to apply this new material it was not necessary to drill holes in existing material, thus avoiding the further temporary weakening of the bridge; on a large portion of the work the full gross area of section could be figured for the new material, as the arc-welding process can develop 100% efficiency without weakening the plate with holes, as is necessary in riveted work, except where it is necessary for the new plates to be applied over existing rivets, in which case holes were provided in the new reinforcing plates large enough to go over the rivet heads and then welded round the holes to the original steel work; and, the new steel could be applied without cutting out present rivets or shapes, thus preserving the original strength of the bridge and keeping the present structure safe for traffic while the strengthening work was in progress.

The progressiveness of the Erie Railroad Co. in recognizing the economic value of the application of arc welding to overcome that which was formerly a serious problem, and the extensive experience and ability of The Electric Welding Co. of America in performing work of this character, have combined with skill in design and workmanship to produce a sterling example which will bear close study by engineers and others who may profitably consider similar work.

Fig. 1 is a general view of the bridge, which has a span of 139 ft. 4 in., a width of 30 ft. 0 in., and a height of 25 ft. 4 in. The bridge carries two main-line tracks.

Fig. 2 shows the new plates applied to the top and sides of the top chord, and the method of welding.

Fig. 3 shows the intersection of the lower portion of the end post and lock member, with the adjacent diagonal web member partially completed. The reinforcement on the large end post is completed, but there is a splice plate to be applied on the diagonal web member over the filler shown welded onto the new main reinforcing plate and butt welded to the original gusset plate and over the gusset plate as outlined in white lines.

HAS WELDED BOILERS SINCE 1919

An interesting letter has been received from the Statom Boiler Works Company, Inc., Anniston, Alabama. This firm has noticed the increased recognition given to the dependability of welding for boiler construction, and the proprietor, commenting on this continued progress, writes as follows: "We have been manufacturing a high pressure steam boiler all-welded since 1919, and have been allowing them to sell themselves. There are a number of our boilers in use in various parts of the country at the present time. Out of this number since 1919 there has been just one boiler which exploded. The people who opposed welding tried in every way possible to make it appear that this boiler exploded because it was welded, and went so far as to send us a photograph of it. We had our representative go to the place where the explosion occurred and he found that the safety plug, which was still in the boiler and had been unnoticed, was completely melted out. More than that, the hull of the boiler on the outside showed that the man operating it only had eighteen inches of water when the

explosion occurred. The fire box sheets had been red hot and collapsed. This will occur on any kind of boiler under the same circumstances. We have proof in our hands now that the welding was stronger than the solid metal in the boiler. We are still making boilers and selling them. We have one in the yard now which has been in service for nine years and is good for nine more. These boilers are all electric-welded and are tested by the most severe tests before leaving our plant."

HAMMERHEAD CRANES OF WELDED DESIGN

Four welded cranes of the hammerhead type were recently constructed by the Orton Crane & Shovel Co., of Chicago, Ill., for the *Chicago Tribune*, two of these cranes being erected at an unloading platform on the Chicago river

These Welded Cranes Handle Rolls of Newsprint To and From Boats. A Welded Trolley and Mast Are Shown in the Center Views.

near the Tribune Tower, and the other two at Ontario, Canada. The cranes at the Canadian end load rolls of newsprint into boats, and the boats are unloaded at the Chicago end by the two welded cranes located there.

The welded construction of the mast and trolley of one of the Chicago cranes is shown in the illustrations. These cranes are equivalent to similar structures rated at about 20 tons capacity. The extreme point of the arm on which the trolley rides is 55 ft. from the pivot.

The various structural parts of these cranes were built in the Orton Crane & Shovel Co. shops, and then these were shipped to the place of erection, where they were riveted or pinned together. All the shop joints were welded, while either pins or rivets were used in the joints made in the field.

These cranes have been giving satisfactory service. On one of the Chicago cranes, the welds at the ends of two rods used as cross braces between two angles at the rear of the trolley were put unexpectedly to a severe test one day when the trolley was put in operation before the stop or bumper had been put in place. The trolley came back with a terrific force against the two braces and bent them, but the welds held and showed no signs of fracture.

INSPECTION METHODS DEMONSTRATED AT CHICAGO

At the December meeting of the American Welding Society, Chicago Section, which was held Friday evening, December 12th, approximately 175 members and guests were gathered to witness demonstrations of various methods of inspecting welds. A welded tank shell containing two longitudinal seams, representing four different welding procedures, was made up for the purpose of this demonstration. Fred Outcalt of the Linde Air Products Co. read a paper on the subject of "The Stethoscopic Method of Inspecting Welds" and provided the necessary apparatus so that those who were interested could obtain a little preliminary practice on the specimen. C. E. Swift of the Westinghouse Electric & Mfg. Co. gave an illustrated talk on the magnetic method of weld inspection; then demonstrated the use of the test meter with the electromagnet and the method of making magnetographs with iron filings. Magnetographs were made of all four sections of the welded specimen. E. W. Page of the General Electric X-ray Corp., Chicago, gave an illustrated lecture on the use of the X-ray for inspecting welds, which included both radiographs and pictures made by the crystal diffraction method. The slides shown included radiographs of the four welded sections of the specimen. A high degree of interest in this program was indicated by the fact that this meeting drew the highest attendance recorded for several years. There were over eighty members and guests present for the dinner at the Palmer House which preceded the meeting. It is the plan of the Program Committee of the Chicago Section to carry out additional inspections and tests of the specimen at a subsequent meeting.

ACETYLENE ASSOCIATION PUBLISHES LAST YEAR'S PROCEEDINGS

The technical papers, reports, and discussions of the 30th convention of the International Acetylene Association, held in Chicago, November 13 to 15, 1929, have been published in a 297-page, cloth-bound book, 6x9 in. in size. The papers, most of which have appeared in the welding magazines or other industrial publications, include six devoted to aircraft welding and the training of welder-mechanics, a paper on the status of boiler welding, one pertaining to the testing of welds, including non-destructive as well as destructive methods, a paper on copper welding, three on structural-steel welding and cutting, and others relating to safety practices, protection against fire, piping systems for commercial buildings and residences, the use of automatic torch cutting machines in production work, and welding in the pump industry. Various uses for carbide gas were given consideration in reports of the technical committees. The report of the Oxy-Acetylene Committee is omitted, but the discussion of the report is printed in full. An index adds to the value of this book as a reference work.

WELDED REPAIRS MAKE EXPENSIVE CASTINGS LIKE NEW

In the repair of castings of considerable bulk or very intricate shape, the welder often can exercise his ingenuity and make a job that is as good as the original casting and sometimes obtain a construction of greater strength than formerly.

The welding of a large 190-ton-pressure toggle press (see Figs. 1 and 2), which had broken across both legs at the crank bearings, is an interesting example of how welding can be used to reclaim broken castings at a low cost compared with the loss entailed if the casting were discarded.

Because of the great size of the casting involved, it was decided to weld it at the customer's plant. The cracks, therefore, were chamfered out and the stud method of repair was used, employing the metallic arc. A total of 74 ½-in. steel studs, 2 in. long, were inserted in the chamfered area in each leg of the press. The welds were then ground off smooth with the surface of the casting.

To add further strength to the weld than that afforded by the steel studs and the weld metal, and also to strengthen the remainder of the casting at the top of the two legs, patching plates were bound firmly to the surface of the casting by means of bolts. The plates were used on all the vertical sides of each leg, except the inside surface, where they were omitted because it was necessary to maintain the original clearance between the two legs of the casting, nor were plates used in the slots below the bearing housings.

The plates on the large surfaces surrounding the bearing housings were cut in such manner that their edges followed the edges of the casting, and they fitted around and flush with the boss extending out from the bearing housings, with a slot cut out below the housing to conform to the slot in the casting. Narrow plates were cut to fit the narrow sides of the casting, both back and rear. All plates were cut out of flat steel by means of the oxy-acetylene torch, and wherever necessary they were formed to fit the surface.

Holes were drilled through the plates to receive the patch bolts, then the plates were held in their correct positions

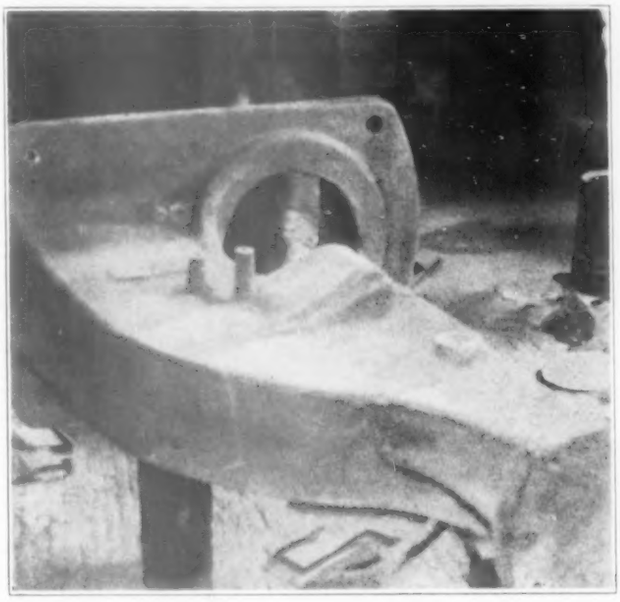


Fig. 3. This Large Shear Press Casting Was Cracked in Service and Welded. The Dark Area Extending Some Distance to the Right of the Two Lugs Shows the Location of the Weld.

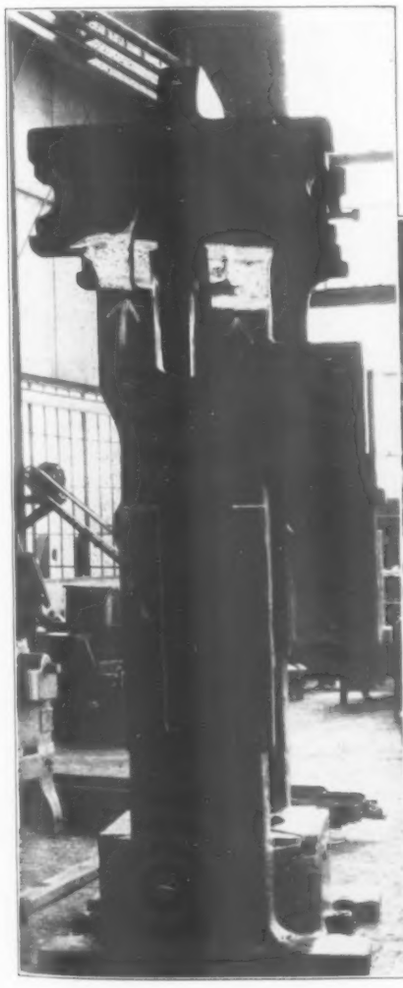
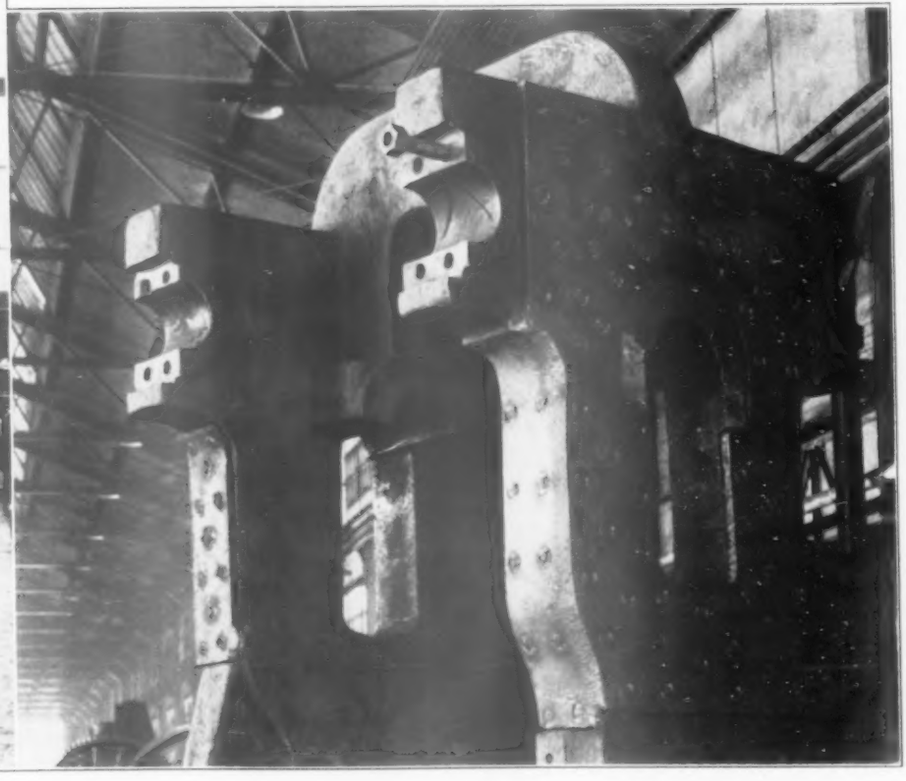


Fig. 1 (*Left*). **Large Toggle Press That Was Cracked in Both Legs and Repaired by Welding. The Area Shown in White Was Chamfered Out, Then Steel Studs Inserted and Metal Deposited by the Metallic Arc.**

Fig. 2 (*Below*). **After the Welds Were Completed, Reinforcement Plates Were Welded to the Outside Surfaces of Both Legs and Held Firmly to the Casting by More Than Two Hundred Patch Bolts.**



on the casting, and locations of the holes in the plates were transferred to the casting by means of center-punch marks. The plates were then removed and the casting drilled and threaded at each of the punch marks to receive ¾-in. bolts, 2 in. long, with countersunk heads. After the bolts were in place, a bead was run around each bolt head. In all, 212

Fig. 4. This Drop-Hammer Frame, Which Was Cracked at Two Places in the Throat, Required 350 Cu. In. of Oxy-Acetylene Welding.

of these patch bolts were used. The plates, after they were in place, were welded to each other along their edges.

Where broken castings, even though of large size, can be removed to the welding shop for repair, the usual method of welding is to champfer out the metal at the line of fracture, then preheat the adjacent metal to a red heat, and then fill the broken section with metal deposited by the oxy-acetylene torch. The shear press shown in Fig. 3 was welded in this manner. The section where the break occurred in this

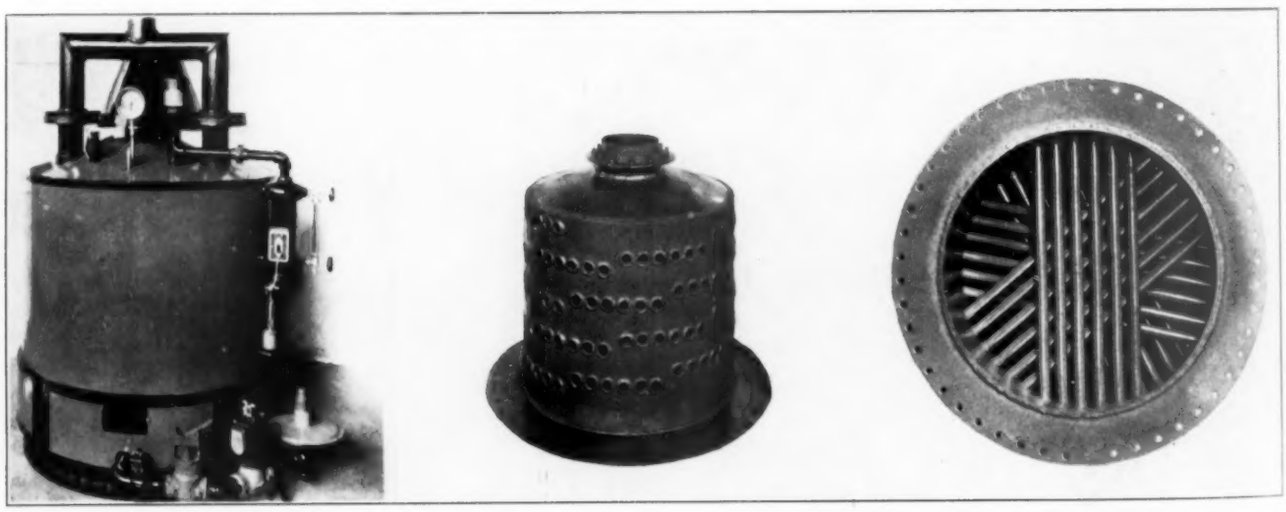
Fig. 5. The Corners at the Small End of This Casting Were Built Up by the Gas Torch After They Had Been Broken Off in Service.

casting was a short distance in front of the two lugs, and part of the repair is evident from the darker area at this point. In this view, the casting is shown lying on its side, with the repair completed. This press is used for cutting structural iron of heavy section.

Another interesting casting repair is shown completed in Fig. 4. This is a frame for a 15-ton steam drop hammer. The throat was cracked in two places, and the repair entailed 350 cu. in. of oxy-acetylene welding.

Sometimes the welder finds it desirable to build up cast-iron parts when making repairs. When corners are chipped off or worn parts worn so they become loose, it is oftentimes cheaper to build up in the low spots than to make a new casting. Fig. 5 shows a column for a press, in which the corners indicated by the arrows were completely built up by weld metal deposited by the oxy-acetylene torch. A total of 82 cu. in. of weld metal was required for this repair.

All these jobs were done by the Western Welding & Equipment Co., of 1432 W. Lake St., Chicago, Ill.



(*Left*) View of Complete Boiler. (*Center*) Exterior of Shell, Showing Welded Tubes. (*Right*) Looking Inside the Shell.

AN ALL-WELDED HEATING BOILER

An interesting example of the use of welding in the construction of heating boilers is shown in the accompanying illustrations, these being three views of an all-welded boiler manufactured by the Youngstown Welding Co., Youngstown, Ohio. The first photograph is that of a complete boiler, which shows ample evidence of the use of welded connections at every possible point in the exterior. The connections for the gas burner shown in the bottom and for the heat-control device are made by means of fittings, on account of the obvious necessity for tees and dismantling in case any replacement or readjustment is required by these parts. The other photographs show the exterior and interior appearance of the shell containing the tubes, which part is 100% welded. The tubes are arranged in layers of six. There are 96 of these tubes welded to the shell. The entire job shows every evidence of simplicity and efficiency.

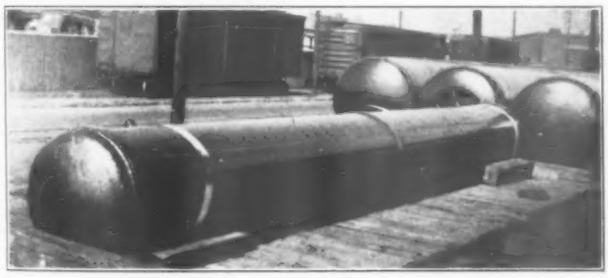
WELDED SEAMS OF PRESSURE VESSELS STRENGTHENED WITH BUTT STRAPS

Heavy steel strip plates, or butt straps, are welded over each welded joint of pressure vessels built in the Columbian Steel Tank plant at Kansas City, Mo., to provide additional joint strength. Tests have shown that this method produces

Welded End of Pressure Tank.

joints that in every case are stronger than the steel plate itself. Vessels with strength to withstand an internal pressure of 1,200 lb. per sq. in. are being fabricated by this method.

On the inside of a tank having a working pressure of only



Butt Straps Welded to Outside of Girth Seams.

5 lb., butt straps are placed about 40 in. apart. As the pressure is increased, the frequency of the butt straps is increased, and at 30 lb. hydraulic pressure the butt straps are placed about 30 in. apart.

One of the illustrations shows the end of a tank for a working pressure of 250 lb. fabricated with butt straps on the inside. The other view shows outside butt straps on tanks designed for 500 lb. working pressure.

HUGE HIGH-PRESSURE GAS HOLDERS ARE ARC WELDED

For the purpose of storing sufficient quantities of gas ahead for heavy consumption periods in cities and densely populated areas, gas companies are erecting large tanks, or "holders" as they are termed.

The accompanying photographs show two clusters of these gas holders in the course of construction for the Southern Counties' Gas Co., of Los Angeles, Calif., the construction of which employs both riveting and arc welding. These huge holders will have a net capacity of 500,000 cu. ft. each. They are to be 103 ft. in height by 50 ft. in diameter in the middle of the cylinder section. Their comparative size can best be determined by the photograph which pictures a completed holder beside the ones under construction. The completed holder is one which has been in use for a number of seasons, and lacks several feet of being as tall as the new ones under construction. The working pressure of these holders will be 50 lb. per sq. in.

The thickness of the metal used in the shell or cylinder portions of these tanks is $1\frac{3}{8}$ in., while that of the heads or

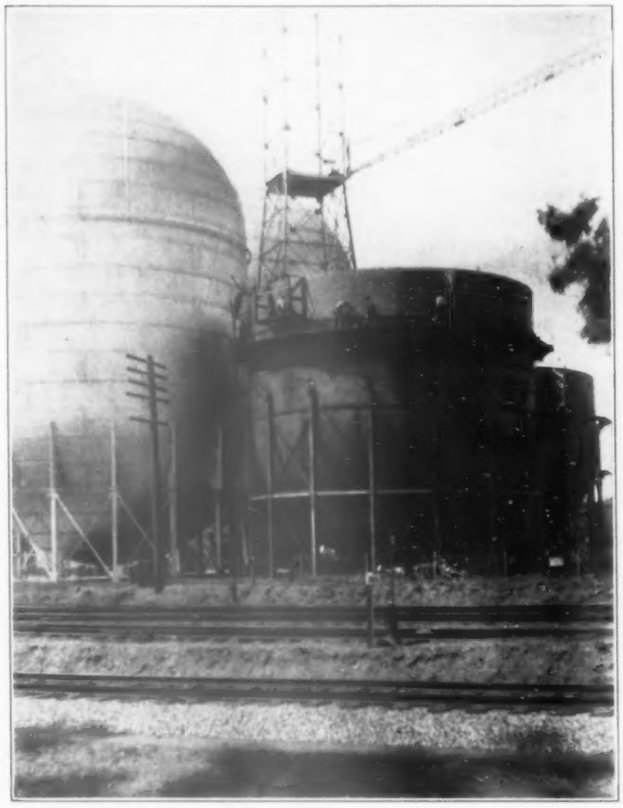


Fig. 1. Large Arc-Welded Gas Holders, Two in Course of Construction.

domes is $\frac{3}{4}$ in. All seams and rivet heads are to be electric-arc caulk welded for gas tightness. The rivets used in the cylinder sections are $1\frac{1}{4}$ in. in diameter, while those in the domes are $1\frac{1}{8}$-in. in diameter. The welding of these rivet heads, together with the footage of the seam welding, will

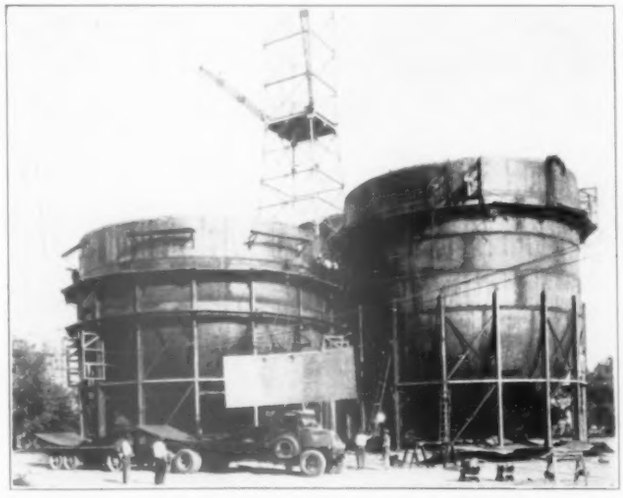


Fig. 2. When These Tanks Are Completed, All Seams and Rivet Heads Will Be Caulk Welded for Gas Tightness.

total approximately 20,000 ft. of welding in each holder.

The holders are supported by sixteen heavy steel arc-welded columns, secured to the holders also by electric welding. The erection towers for hoisting material, etc., as seen in the pictures, are 140 ft. high with 80-ft. booms.

Fig. 1 is a cluster of four of these gas holders which are being erected at Santa Ana, Calif., and Fig. 2 shows the erection of two additional holders being erected at Pomona, Calif. Construction is by the Western Pipe and Steel Co., of Los Angeles, Calif., to whom credit is due for the courtesy of furnishing the data for this article.

INCREASES PENETRATION OF X-RAYS

X-rays at 500,000 volts, more than twice as high a voltage as is being used in today's most powerful therapy tubes, have been attained by Dr. W. D. Coolidge, of the General Electric research laboratory at Schenectady, N. Y. Such a decided increase in voltage, and hence increase in penetrating power of the rays, has been made possible by a system of "cascading" the tube. Another X-ray tube is now being developed which will operate at 900,000 volts.

In the new 500,000-volt tube, the target replaces the "window" of the cathode-ray tube so that, instead of cathode rays being emitted by the tube through such a "window," X-rays of exceedingly high penetrability are generated by the impact of the electrons (or cathode rays) on the target. This eliminates the difficulty heretofore encountered of a "cold cathode" effect, whereby at high voltages current flowed through the tube even when the cathode filament was not heated.

The highest-voltage Coolidge X-ray tubes used commercially at present are of 200,000 volts peak capacity, and are of two types—water-cooled and air-cooled. Both are adaptable for X-ray therapy. The air-cooled type has been used to considerable extent in industrial applications of X-rays, since the high voltage gives the necessary penetration required for examining the heavier metal objects. Industrially, higher voltages will permit radiography of thicker metals and shorten the time required for exposure.

GAS PRODUCTS ASSOCIATION ADOPTS NEW EMBLEM

Members of the Gas Products Association have been notified that a new emblem has been selected for use by members, a copy of which is shown below. It is considered that

the new emblem is more indicative of the industry represented by the Association than the one previously used. "It is our aim," says the announcement, "to establish this emblem in the minds of the public as standing for the development of the gas-welding and cutting industry."

Other important G. P. A. announcements refer to the annual midwinter meeting, which it is announced will be held during January, and to the appointment of all committees.

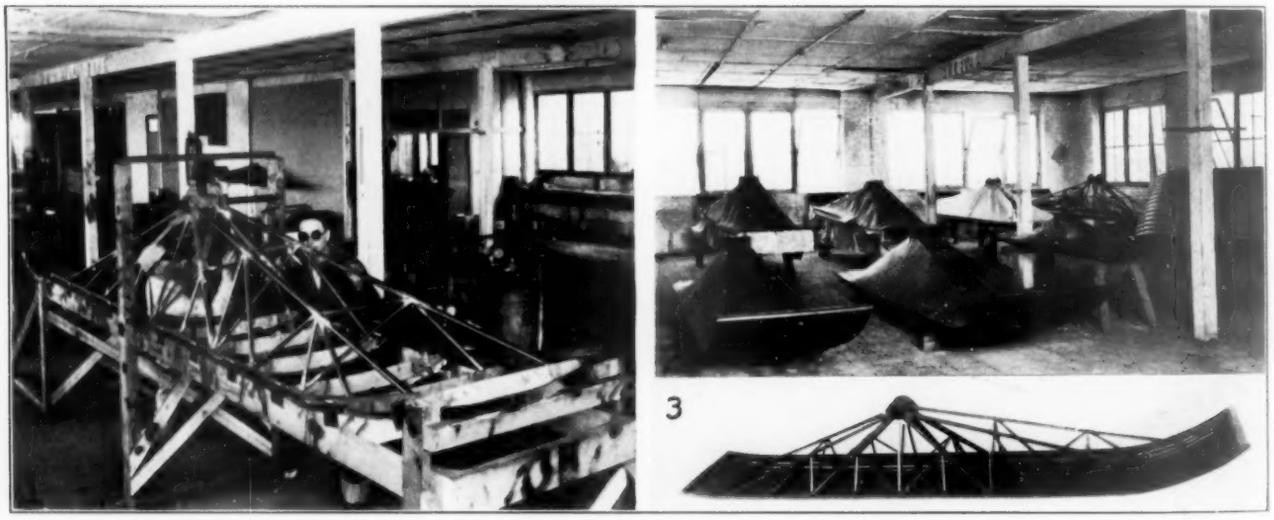


Fig. 1. Welders Working on Frame of Ski. Fig. 2. Fabric Covers Protect the Framework From Snow and Ice. Fig. 3. The Corrugated Duralumin Runner Is Riveted to the Frame.

WELDED LANDING SKIS FOR ARMY PLANES

A very interesting piece of welding work is illustrated by the accompanying photographs. The pictures are of airplane landing skis which are to be used in the snow country of the North where ordinary landing wheels are very impracticable.

The Welded Products Co. of Bell, Calif., recently completed a large contract of these skis for the U. S. Army Air Service. The skis are of two sizes, for different types and sizes of planes.

The framework of these specially fabricated skis, as shown in Fig. 1, is of oxy-acetylene-welded chrome-molybdenum-steel construction, which provides the utmost of strength without prohibitive weight. The accumulation of ice and snow inside the ski in landing or taking off is prevented by a fabric cover laced over the frame, as shown in Fig. 2, which adds a degree of safety where a rough or uneven field surface is encountered.

Fig. 3 shows the completed ski (without the fabric cover), the bottom or runner of which is of corrugated duralumin, heat treated and riveted to the welded frame. A partial view of one of the bottoms is also shown in Fig. 2.

The Welded Products Co. are specialists in cutting, forming, and fabricating steel, and have recently added automatic oxy-acetylene cutting equipment, presses ranging from 7½ to 325 tons capacity, and also preheating and annealing furnaces with a maximum capacity of 4 by 20 ft.

SIXTH ANNUAL WELDING CONFERENCE AT PURDUE

The Welding Conference held at Purdue University, Lafayette, Ind., on December 10th and 11th, was the sixth successful attempt to bring before the industries of the state a close-up picture of the most up-to-date practice in the applications of all forms of welding. The Engineering and Extension Department and the Department of Practical Mechanics are to be congratulated on the continued interest and expressions of appreciation for their efforts to make this event so valuable to the men who come not only from Indiana but also from several neighboring states to hear the papers and witness the demonstrations. Two days and one evening were crowded with the activities of the program.

Some of the subjects discussed included new phases of welding, training welders, use of gas and electric welding in manufacturing operations, testing welds, structural welding, riveted vs. welded joints, hand and multiple cutting, machine welding, welding alloys and special steels, resistance welding, and welding kinks.

Exhibits and demonstrations by manufacturers of welding equipment and the Practical Mechanics Department included the application of Stellite and similar metals, cutting with hand and machine torches, welding aluminum, bronze welding, the oxygen torch, cutting cast iron, welding cast iron, and tests of welds.

Interest in the program and demonstrations was very high throughout the conference. The fact that the registration of guests totaled 287, which is a record-breaking figure, is an indication of the high value placed on this program by those who live close enough to Purdue University to be able to attend this annual welding event.

PAPERS AND EXHIBITS AT MILWAUKEE ARC-WELDING CLINIC

The arc-welding clinic held in Milwaukee, Wis., December 1st to 3rd, under the joint auspices of Marquette University and the Northwestern Manufacturing Co., was characterized by a large attendance from all parts of the state and by a high degree of interest.

The program of papers was as follows: "Metallurgy of Arc Welds," by J. E. Schoen, Assistant Professor of Mechanical and Metallurgical Engineering, Marquette University. "Recent Developments in Arc Welding," by K. L. Hansen, consulting engineer, Northwestern Manufacturing Co. "Electric Arc Welding of Aluminum," by W. M. Dunlap, research engineer, Aluminum Co. of America. "Redesign of Machinery and Machine Parts," by Otto Voss, superintendent of boiler shop, Allis-Chalmers Manufacturing Co. "The Relation Between Quality and Economy," by L. C. Monroe, sales department, *The Welding Engineer*. "Metal Arc Welding With Copper Alloys," by I. T. Hook, research engineer, American Brass Co. "Structural Steel Welding," by A. V. Wilson, Mississippi Valley Structural Steel Co. "A Future for Engineers in the Welding Industry," by H. S. Card, editor, *The Welding Engineer*. "Miscellaneous But Profitable Applications of Arc Welding," by Robert Notvest, welding engineer, Indianapolis, Ind. "Welding of High Pressure Vessels," by Emil Behling, superintendent of welding, Vilter Manufacturing Co.

One of the most interesting features of the clinic was the display of welded materials offered by various manufacturers from the Milwaukee district. The names of the companies exhibiting and the material exhibited were as follows:

Company	Material Exhibited
Alloy Metal Products Co. Milwaukee, Wis.	Allegheny metal parts and fittings fabricated by arc welding.
Federal Steel Sash Co. Waukesha, Wis.	Arc-welded sash and window frames.
Hall Steel Joist Co. Milwaukee, Wis.	Arc-welded steel floor joist.
Harnischfeger Corp. Milwaukee, Wis.	Arc-welded gear case, and photos of bases and other parts fabricated by arc welding.
The Heil Co. Milwaukee, Wis.	Test bars showing strength of arc-welded aluminum and Allegheny metal.
C. Hennecke Co. Milwaukee, Wis.	Arc-welded fireproof sidewalk door.
B. Hoffmann Mfg. Co. Milwaukee, Wis.	Tube-Turns and arc-welded pipe fittings.
Kearney & Trecker Milwaukee, Wis.	Arc-welded gear case, and photos showing application of welding in their plant.
Lakeside Bridge & Steel Co. Milwaukee, Wis.	Steel beam illustrating difference between riveted and arc-welded construction.
The C. M. & St. P. Railroad Milwaukee, Wis.	Worn railroad frog built up by arc welding.
Milwaukee Welded Steel Co. Milwaukee, Wis.	Chairs, bins, and other furniture fabricated by arc welding.
Northwestern Mfg. Co. Milwaukee, Wis.	Motor rotor brazed with arc torch, and welded trucks.
The Oilgear Co. Milwaukee, Wis.	Jigs and a broach base.
F. Rosenberg Elevator Co. Milwaukee, Wis.	Elevator parts fabricated by arc welding.
A. O. Smith Corp. Milwaukee, Wis.	Arc-welded oil pipe; samples of welded pressure vessel which had been destroyed to prove weld was stronger than parent metal; also movies showing welding operations in their plants.
Standard Sheet Metal Works Milwaukee, Wis.	Arc-welded brass parts.
The Vilter Mfg. Co. Milwaukee, Wis.	Arc-welded ammonia header and fittings.
Allis-Chalmers Mfg. Co. West Allis, Wis.	Photos showing application arc-welding process in their plant.

FUNDAMENTALS DISCUSSED AT LOS ANGELES MEETING

The November meeting of the American Welding Society, Los Angeles Section, was held Tuesday evening, November 18th. After-dinner cigars were enjoyed during the showing of motion pictures through the courtesy of Perry F. Backus, local attorney and Cine-Kodak enthusiast, and the Eastman Kodak Co.

The local chairman, W. A. F. Millinger, introduced an unexpected visitor, R. H. Atkinson, past chairman of the San Francisco Section, who spoke regarding that section's activities and voiced his approval of the decision of the Los Angeles Section to endeavor to hold several meetings in the near future in local welding shops.

The feature speaker of the evening was Prof. Arthur E. Hoare, of the University of Southern California, whose subject was "The Welder's Eyes." Preceding this talk, a picture was shown on the mechanical operation of "How We See." Prof. Hoare treated the subject from the welder layman's standpoint. He entered into his subject wholeheartedly, and by means of diagrams on the blackboard and vivid mental impressions he held his audience's closest attention throughout the whole talk.

After Prof. Hoare's address and a short recess, R. H. Wulf, chemical engineer, continued his lecture on "The Chemistry of the Welding Flame," which centered around the chemical constituents of the welding flame. This is an educational feature continued from recent meetings, and which it is hoped may be continued indefinitely.

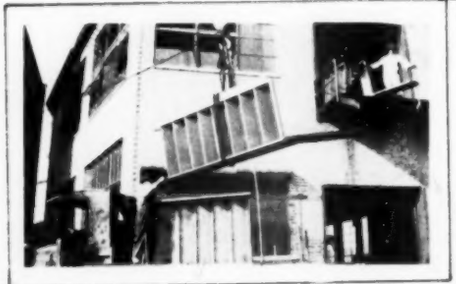
C. Oatis gave a brief outline of the welding of the Dallas (Texas) Power & Light Co. office building, which has just been completely fabricated by electric welding.

At the left are shown a series of trusses in the roof structure of the welded auditorium in the court of General Electric research laboratory at Schenectady, N. Y. Note the upper and lower chords consisting of half an I-beam, also the arch type of truss.

WELDING STRUCTURAL STEEL

(Photos by courtesy of General Electric Co. and Paxton & Vierling Iron Works)

The picture below is of a lintel made of two I-beams, joined at an angle of 30 deg., with a plate cut and welded to the bottom.



An unusual application of arc welding in wrought anchors welded to channels used as pavement supports, is shown in the view above. The center picture shows a welded staircase made of stock structural shapes.

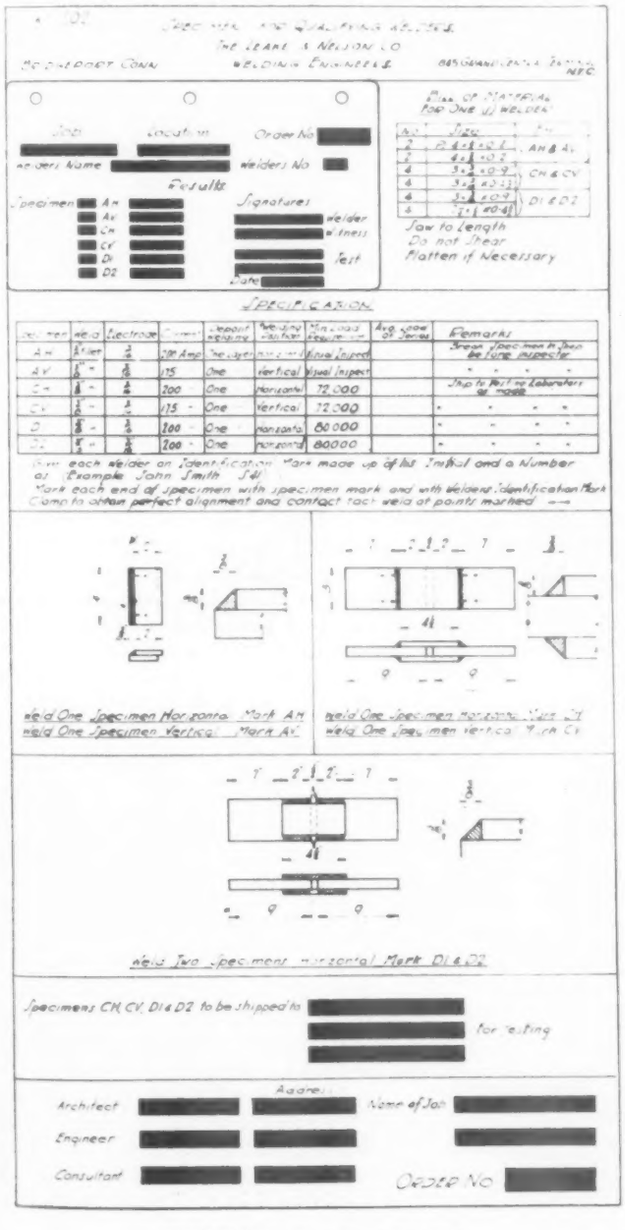
Welder at work on girder-to-column connections on the structure shown in the large illustration at the top.

TRAINING AND SUPERVISING WELDERS FOR STRUCTURAL-STEEL WORK

The insuring of good welds in the field when erecting or strengthening such structures as bridges and buildings, is a problem that must be met by contractors who are responsible for such work. The Leake & Nelson Co., of Bridgeport, Conn., who carry on a general welding engineering business in the consulting and contracting fields, require all their field welders to pass a rigid qualification test, and specimens of their work are tested periodically. In addition, they conduct a school for the training of structural-steel workers as welders.

This company has been engaged in a consulting or contracting capacity on such well-known field-welding operations as the 14-story office building of the Edison Electric Illuminating Co., at Boston, Mass., the Sterling Memorial Library of Yale University, and other projects of equal importance, including several bridge-strengthening jobs, all employing welding to a more or less extent.

This company's Field Welding Test Sheet No. 302 is reproduced in Fig. 1. This is the standard qualification test sheet; and all welders must qualify in accordance with



Field Welding Test Sheet No. 302.

LEAKE & NELSON COMPANY, Inc.

Works & General Office
203 Ash Street
Bridgeport, Conn.
Tel. Noble 3600

ELECTRIC WELDING DEPARTMENT

STUDENT'S REPORT

New York Office
Grand Central Terminal
Room 1848
Tel. Murray Hill 7187

Classes
Tuesday, Wednesday, Thursday
7:00 to 9:00 P. M.

Date.....

Name .....

Address ..... Tel. No.....

Age..... Married or Single.....

Education .....

Experience as:—Bridgeman..... Apprentice ..... Shop Welder.....
(Check which)

If so, how long.....

Type of Welds				
Striking Arc				
Maintaining Arc				
Recovering Arc				
Speed of Travel				
Resuming Deposit				
Position				
Penetration				
Bead				
Weaving				
General Appearance of Work				
Result of Specimen Test				

Characteristics:—

Temperament ..... Conscientiousness .....

Dependability ..... Reaction to Criticism.....

General Remarks:.....

.....

.....

.....

.....
Instructor

Instructor's Report Blank for Students.

the specifications shown in this sheet or any others that the architect or owner may desire, and as often as they desire thereafter. In addition, the company qualifies its welders every thirty days whether or not it is required.

The welders also are required to weld special specimens, which are broken at the building site on each project and witnessed by the inspector. This, explains A. G. Leake, president of the company, serves to keep the welder constantly on the qui vive, and insures consistently good work.

Fig. 2 shows the report blank that is used in the company's training school. The instructor fills out one of these for each student and signs it.

BATTLEDECK FLOORS TO BE TESTED BY BUREAU OF STANDARDS

A comprehensive and extensive program of load tests, fire-resisting tests, and sound tests of the battledeck floor is being conducted for the American Institute of Steel Construction by the Bureau of Standards at Washington, D. C., according to the annual report of F. H. Franklin, Director of Engineering Service of the Institute at the eighth annual convention recently held at Pinehurst, N. C.

Fire exposure will be applied to the floors from below in twelve of the test series, and in six tests fire exposure from above will be applied by burning combustible materials such as wood and paper in amounts from 10 to 40 lb. per sq. ft. of floor area. Various degrees of protection will be given the upper surfaces of the welded steel-plate floor for these tests, from the bare plate to a series of five varying types of floor coverings.

The fire exposure from below will be obtained with a gas furnace using 48 horizontal burners. The protection applied to the beams will vary from a ¾-in. thickness of plaster on metal lath to 2-in. gypsum slabs hung from the lower beam flanges to form a suspended ceiling. Three

tests in which a hose stream will be applied to the heated floor after a period of fire exposure will also be included.

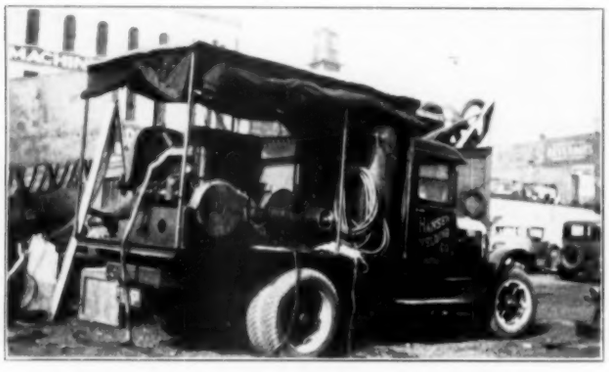
The floors will be supported during the tests within a heavy steel restraining frame, and superimposed loads of 45 to 160 lb. per sq. ft. will be maintained constant during the fire tests. In some tests the floor connections with the restraining frame will be designed to give full restraint to the construction, and in other tests the ends of the beams and plates will be freely supported with opportunity for expansion. The test floors will be 18 ft. long and 13½ ft. wide. The beams will span the full length of the floor, except in five tests where the beams will be supported on a girder at an intermediate point to introduce the details of fireproofing required for the girder.

The load tests will consist of strain-gage measurements on one panel, which will be placed in the restraining frame used in carrying out the fire tests. The tests will determine the location of the neutral axis of the T-beam section formed by the I-beams and plates, the intensity of stress in the upper surface of the plate between beams, the shearing stress on the welds, and the yield point, the last-named test requiring the increasing of the live load in increments up to the point of failure.

Six sound tests on battledeck-floor panels, each with a variation in ceiling protection and floor covering, will also be carried out.

TOLEDO WELDING FIRM BUILDING A WELDED BOAT

The Hansen Welding Co., Toledo, Ohio, recently started work on the construction of an all-welded 35-ft. cruiser. The bow of this boat is shown in the left background of the illustration. In the foreground sits one of the portable equipments operated by the company. Mounted on the truck are the gasoline engine, welding generator, and an



Bow of Welded Boat Is Shown in Left Background.

air compressor. The Hansen company operates two trucks and one barge, each of which is equipped with air compressors and complete welding equipment similar to the one shown in the picture.

NEW EDITION OF CODE FOR WELDING AND GAS CUTTING IN BUILDING FIELD

The American Welding Society announces the publication of the 1930 Edition of Code 1, Part A, Code for Fusion Welding and Gas Cutting in Building Construction. This edition, quoting from its preface, "includes an appendix whose use obviates the necessity of consulting the publications of the American Bureau of Welding cited in the 1928 edition; and the body of the code has been reworded to correspond. The matter given in the appendix is primarily a digest of the publication previously referred to, with additional explanatory matter where needed to make it more applicable to code purposes."

The 1930 Edition, as explained by the Committee on Building Codes under the A. W. S., is, in other respects, essentially as published in 1928, except for minor changes in the wording of three paragraphs in the body of the Code.

The changes apply to Sec. 3, Par. 1, wherein the committee has limited the application of structural welding to a cited specification for base-metal parts; to Sec. 4, Par. 1, wherein a design criterion for fillet welds, placed transverse to the direction of stress, has been included; and to Sec. 5, Par. 5, wherein beveling of butt joints which have only one edge beveled for welding have been definitely classified.

Copies of the 1930 Edition of Code 1, Part A, are available at American Welding Society headquarters, 33 W. 39th St., New York City.

DEVELOPS EQUIPMENT FOR TILTING AUTOS FOR REPAIR

Information received from Williamson's Welding Works, located at 207 South E St., San Bernardino, Calif., indicates that this concern, of which Alva Williamson is the proprietor, has built up a business of considerable proportions on the specialty of rebuilding flywheel gear teeth. The process used in the Williamson plants involves the welding

Showing Auto Tilted for Repairing Starter Teeth.

of the teeth without removing the flywheel from the car. The car is driven onto a special tilting frame, which was patented by Mr. Williamson in November, 1928. When the frame is tilted, the flywheel is easily accessible by either moving the pan or cutting the flywheel case. A special flux-coated high-carbon steel electrode is used to fuse new metal directly onto the base or root of a broken, chipped, or multilated tooth. The tooth is then ground to the proper size and pitch. It is said that the average time for making a repair is from one to two hours, depending on the accessibility of the flywheel. The firm has branch shops at Los Angeles, Long Beach, Hollywood, San Diego, Oakland, San Francisco and San Jose, and has licensed other shops to use the patented tilting device for this purpose. A circular recently issued states that over 25,000 flywheels were repaired by this procedure in 1929.

DATA SHEET ON BATTLEDECK FLOORS

How to compute stresses in battledeck-floor construction, is described in A.I.S.C. Technical Data Bulletin No. 3a, published by the American Institute of Steel Construction. Examples are given, and the amount of welding required is determined, based on A.W.S. specifications. A table is given of deflections, section moduli, maximum moments, etc., for various 6-in. beams and joints used in conjunction with 24x ¼-in. plates.

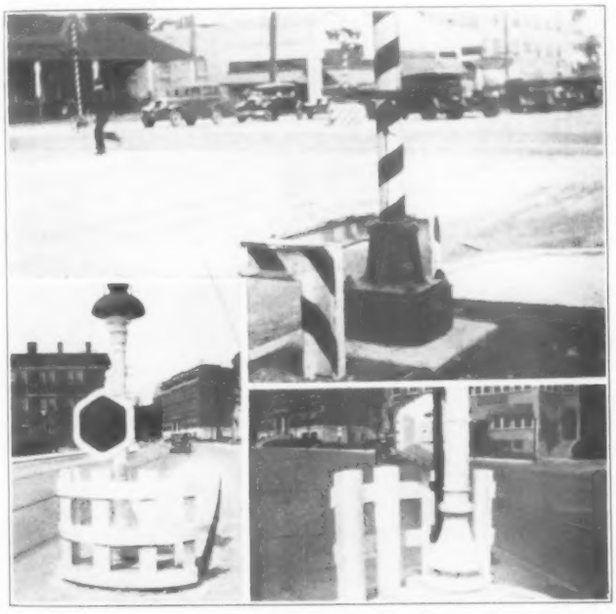
Hints for the Welder

WHEN YOU FIND a new way to do a hard job, or finish a particularly interesting weld, can you describe how the work was done? . . . . . Have you learned some little stunt every welder ought to know? . . . . . Write to us about these things . . . . . This department helps you welders to help each other. Write up your ideas any old way and just make rough pencil sketches . . . . We'll fix them up for publication.

IDEAS IN WELDED PROTECTORS FOR LAMP AND SIGNAL POSTS

Two types of welded protectors that serve as buffers against reckless motorists are shown in the illustrations. The one in the upper view stands as a guard between a railroad-crossing signal and the traffic of a busy street. It is made of discarded railroad rails cut to proper size and welded, and forms its own anchor to the ground.

The two lower pictures are views of a safety-zone and



Welded Guards Made From Discarded Rails.

lamp protector which comprises four pieces of old rail embedded upright in the pavement, with three pieces of boiler plate arc welded to them. This makes a neat and effective barricade against the carelessly driven automobile, and more than three hundred of these protectors are already installed in the city of Cincinnati.

UNUSUAL WELDING APPLICATIONS

A great variety of work in both production and repair welding is shown in the photographs submitted by Geo. T. Kerr, of the firm of McIntyre & Kerr, Berkeley, Calif., in the photographic contest conducted this year by the Stoody Company, of Whittier, Calif. This group of photographs was awarded first prize in the group calling for unusual welding applications. Much of the work shown exhibits originality in design, and first-class workmanship is evident in all the jobs. The winning photographs in Class 1 were reproduced in the September issue of *The Welding Engineer*.

Fig. 1 shows an all-arc-welded motor support. Each of these designs saved 85 lb. in weight and $13 in cost compared with the malleable-iron casting. Mr. Kerr reported at the time of submitting this photograph that a total of $450 had been saved over castings for this one part.

Fig. 2 is a welded jig for machining the combustion chamber in the cylinder heads of gasoline engines.

Fig. 3 shows a plug gage, the ends of which had become worn under size. To repair this, the ends were ground down a little smaller in diameter and then Stoodite applied, after which the ends were ground to the exact size required. The Stoodited surface outwears hardened steel, and its application allows expensive and accurate tools that have been worn undersize to be reclaimed with the minimum of expense and effort.

Figs. 4, 5, and 6 are pilots or guides used in conjunction with jigs or fixtures. Fig. 5 shows a pilot with three deposits of Stoodite, more or less evenly spaced, running as far up the bar as required. Fig. 4 shows the same bar equipped with a bushing as well as with a counterbore on the end. The bar is ground to size after the Stoodite is deposited. Fig. 6 is a bar for holding tungsten-carbide tools for a boring or sizing operation on automotive pistons, and a slightly different method of finishing the Stoodite was employed. The bar was turned about ⅛ in. undersize on the small end and, as in the case of the other pilots, three lines of Stoodite about ¼ in. wide were deposited lengthwise along the bar. A groove was then cut in both edges of each strip of deposited metal, and the diameter ground to size. The grooves give the Stoodite a sharp edge, which acts as a scraper and prevents fine chips from working in.

Fig. 7 is a snap gage—one side for "GO" and the other for "NO GO." The usual method of making this gage is to machine out to a rough size, using tool steel, then heat treat and grind to the exact size. The gage shown, however, was cut out of machine steel by means of an acetylene-torch machine, then Stoodited and ground to size.

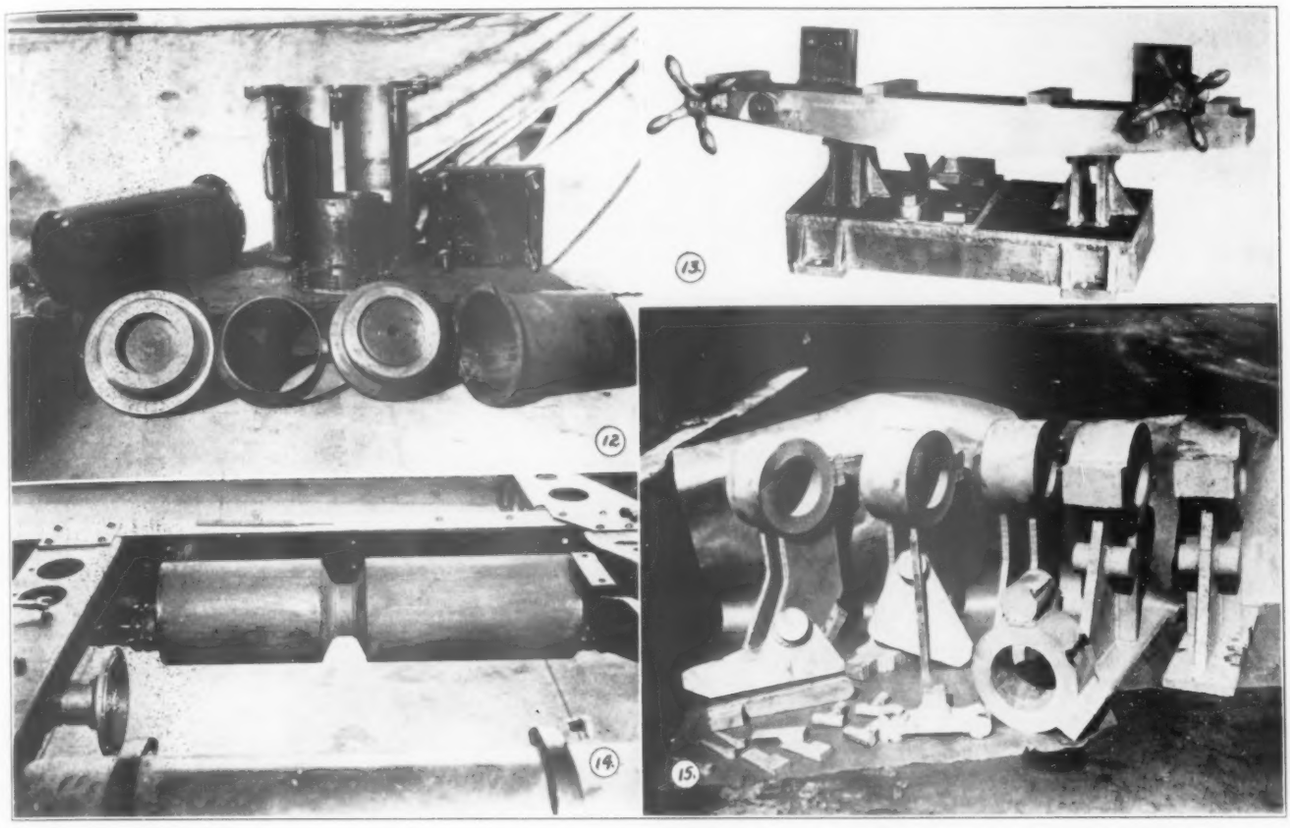
Fig. 8 is a welded motor support for a bus engine, showing the parts at the top, then the welded assembly, and at the bottom the part machined and finished. The plate was torch cut to shape and the hole burned out; then the V was machined out on a lathe. The other pieces are standard seamless tubing.

Fig. 9 shows in the top view a fixture, having the tips of the four arms Stoodited and then ground, and in the bottom view a welded jig which plainly shows three lines of Stoodite deposited on the surface from which the work is to be located. The use of hard-facing material deposited by welding is better than the conventional method of screwing hardened and ground strips to the jig. The center view is a jig part with pads of Stoodite; a piece of carbon was used to keep the deposited metal in shape, after which the Stoodite was finished by grinding.

Fig. 10 illustrates oxy-acetylene-welded starter and generator straps; also a broken magic chuck, repaired by weld-

A Miscellany of Welded Jobs

1. Welded motor support. *2.* Welded jig. *3-7.* Various types of gages and pilots, surfaced with hard-facing material and ground to size. *8.* Parts and welded assembly of motor support. *9.* Showing a fixture, a jig part, and a welded jig, all with pads of Stoodite applied. *10.* Starter and generator straps; also magic chuck before and after welded repair. *11.* Two plate assemblies with Stoodited pads for guiding the work.



These Flanging and Piercing Dies, Fixture, Gas-Engine Muffler, and Balancing-Machine Parts Are All-Welded.

ing, in which the right-hand view shows the chuck with the tang twisted off. the center view shows a piece welded on, and the finished repair is shown on the left.

To repair the chuck, the broken shank was cut back about 2 in., then a piece of S. A. E. 3140 steel long enough to make the shank full length was arc welded on the end. Before welding, both pieces were V'd down to within ¼ in. of their centers. The welded chuck was buried in lime to cool, then the shank machined to its original size and shape, after which the extreme end of the tang was heated for hardening, then drawn to 1,000 deg. F., at which the tool was ready to use. Each of these chucks (size No. 2) has a value when new of $7.15, and $2.00 will put it back into service with a tang stronger than the original. The shop of McIntyre & Kerr has repaired hundreds of such tools by this method. The ordinary method of repair, in which sufficient metal is built up to re-machine a new tang, produces a tool that is not strong enough.

The starter and generator straps shown were made by cutting strips 2½ in. wide and of the proper length out of a ⅛-in. cold-rolled steel plate, then cutting a notch out of one end, which end was then curled in a die. Next the curled end was welded, the piece bent to the required form, and the two clips formed on a punch press and welded in place, which completed the operation.

The part shown at the left in Fig. 11 consists of a gage base plate, a center plate, and a pin, both plates being cut out of plate by means of a torch. The ¾-in. center plate is surface ground, a hole bored and reamed in the center, and the piece rough-turned about ⅛ in. below the finished diameter. Eight Stoodite pads, each about 1 in. long, were then welded around the periphery and ground to the exact diameter, after which the hole for the vertical pin was bored accurately and the pin hardened and ground and pressed into place.

The other piece shown in Fig. 11 is somewhat similar to the part just described. This is the end plate of a jig for drilling holes around the bell or flywheel end of a truck-motor crankcase. The lower plate carries the bushings for guiding the drills; and bolted and doweled to this is another plate for locating the case correctly for drilling, this plate having about 40 Stoodite pads welded to its periphery. The pads are finished by grinding to give the correct diameter. The two end pieces are also Stoodited and ground.

Fig. 12 is an illustration of some arc-welded dies for flanging and piercing the pieces shown on the extreme right and left. The hinged piece shown in the center was rolled from ⅜-in. plate and the rim and lugs welded in place and machined. The forming punches shown in front are of cast iron.

Fig. 13 is a welded fixture for milling a gasoline-engine part.

An all-arc-welded muffler for an automobile bus is shown in Fig. 14. The inside part of this muffler also is arc welded.

Fig. 15 shows a group of welded parts for a balancing machine, and illustrates some of the details of which these parts are formed.

THE LINDEWELD PROCESS

A new method of oxy-acetylene welding known as the Lindeweld process has been introduced by The Linde Air Products Co., 30 East 42nd St., New York, N. Y., as a part of its process service. Although the Lindeweld process is used at present chiefly for the welding of pipe, future developments are expected to lead to its application in many other industrial welding operations.

In the welding of pipe for oil and gas transmission, it is reported that the process has resulted in savings of from 30% to 60% of the time required to make a weld by the methods previously employed, depending upon the size of the pipe. Oxygen and acetylene consumption have also been reduced considerably. Consistently higher strength welds are obtainable so that no sacrifice of quality has been made for the benefit of the increased speed. In tensile tests made in the field on welded specimens, the welds have invariably

outpulled the pipe. Good ductility has also been shown in bend tests.

The Lindeweld process is the result of years of laboratory research and field testing. It depends essentially on a new method of blowpipe manipulation and upon the use of a new welding rod introduced for that purpose, known as "Oxweld No. 24 Lindeweld Process Welding Rod." Experienced welders find no difficulty in adapting themselves to the new method. The Lindeweld process is also more quickly learned by student welders than the former welding method, according to recently issued statements. Oxy-acetylene welding has played an important part in the development of long-distance-pipe-line construction, and this improved welding process will undoubtedly add to the impetus which pipe-line work has received during the last few years.

The new process has passed the experimental stage, as more than 300 miles of high-pressure pipe line welded by this process are now in the ground. The illustration shows

Handling Pipe Fabricated by the Lindeweld Process.

a 20-in.-diameter natural-gas pipe line which has been welded by the Lindeweld process being cold bent to fit the contour of the terrain. Cold bending of pipe of this size to such an extent is a good test of the strength and ductility of the welds.

CHIP, GRIND, DRILL, ALL WITH ONE TOOL

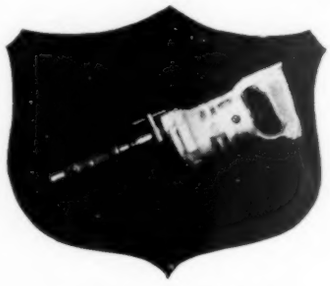
A new tool that the welder will find useful for chipping welds and for light grinding work is known as the Milwaukee Hammer-Drill, and is manufactured by the Milwaukee Electric Tool Corp., Milwaukee, Wis. Other purposes to which this tool can be put are peening, drilling, and polishing.

The drilling movement is changed to a hammering movement by means of a specially constructed sleeve that fits over the shaft and is clamped to the casing of the tool. The tool operates from a 110-volt circuit, either a.c. or d.c., and weighs 9 lb. It can also be designed for other voltages.

The chuck has a speed of 3,600 r.p.m.; and, with the sleeve attached, hammering or peening blows are delivered at the rate of 3,600 per minute.

The grinding wheel that may be used with this tool is limited to a 6-in. size with an approximate width of ½ in. This is sufficient for finishing welds.

The chisel supplied with the tool has a ⅝-in. diameter shank. The blows are very rapid and a fairly heavy cut can be had, making the tool particularly desirable for chipping out cracks in cylinder blocks and for removing scale from



Milwaukee Hammer-Drill.

cast iron and from electric welds preparatory to laying on a new bead. The tool is also adaptable for peening electric welds.

Used in connection with a star drill, this tool will drill a ¾-in. hole, 2½-in. deep, in concrete in one minute; or a 1-in. hole, ¾-in. deep, in the same time.

NEW SPOT WELDER BY MICRO PRODUCTS

The Micro Products Co., of Peoria, Ill., manufacturers of the Micro butt welder, recently introduced to the market a new light-duty spot welder. The outstanding feature of this new welder is that it is fully automatic without using a motor. The welding electrode is actuated magnetically by a solenoid which not only gives instant positive action but also produces even pressure on the stock until the weld is completed to the proper depth, at which instant the automatic switch cuts off the current supply. The new machine has a 27-in. throat and a capacity to weld two pieces of stock up to ⅜ in. in thickness or two ⅛-in.-diameter cross wires. It is claimed that the machine is particularly adapted to cross-wire work.

PISTOL-TYPE AIR TOOL CHIPS METAL AT RATE OF 6000 BLOWS PER MINUTE

The Kipp air chipping tool delivers light cuts at the rate of 6,000 blows per minute, and "walks right through" steel, stone, soft metals, and wood, according to claims made by the Madison-Kipp Corp., Madison, Wis., manufacturers of this new device. This tool has a pistol grip and pistol body, and it is said to produce no vibration in the grip hand of

This Rapid-Fire Chipping Tool Can Be Used in Inaccessible Places.

the operator, and the fatiguing strain that is often associated with pneumatic chisels is absent.

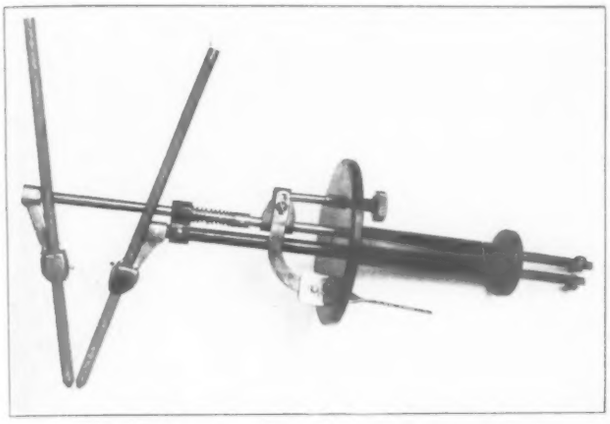
Kipp chisels are inserted into the barrel of the holder and held in place by means of a spring clamp. The chisels have pentagon shanks and may be inserted with any of the five sides in the up position. The chipper itself will operate in any position, giving the operator freedom of action for clearance and convenience, which is particularly important in the

chipping of scale from weld beads that are located in unfavorable positions, or in the peening of welds.

The Madison-Kipp Corp. is now entering production on this new tool, and it will be ready for delivery on January 1st. Firms with satisfactory credit rating can obtain one on 10-days' trial. Each tool is supplied with one chisel, hose, and hose connections.

DOUBLE-CARBON ELECTRODE HOLDER

The Electric Arc Cutting & Welding Co., of Newark, N. J., are marketing an improved double-carbon electrode holder to be used as an electric-arc brazing torch. The construction is shown in the illustration. This brazing torch is said to operate for one hour on 5c worth of power at the

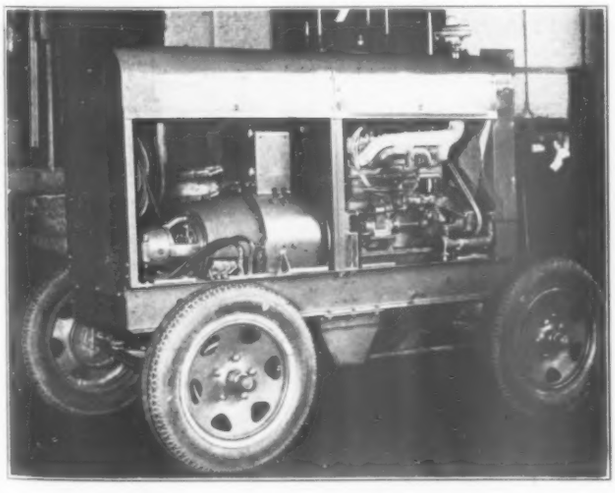


This Arc Brazing Torch Operates at Five Cents per Hour.

rate of 3c per kw.-hr. It will operate from any arc-welding machine—either a. c. or d. c. In addition to its use as a brazing torch, it is also recommended as a source of heat for bending frames or for preheating where a quick, localized heat is necessary.

WELDER FOR FIELD AND STREET SERVICE

A special type of portable 300-amp., single-operator welder, manufactured by the Westinghouse Electric & Manufacturing Co., of East Pittsburgh, Pa., can be towed or transported from job to job at road speeds, thus providing quick and ready service. The machine is particularly adaptable for use by public utilities, street railways, and other concerns whose work is widely scattered.



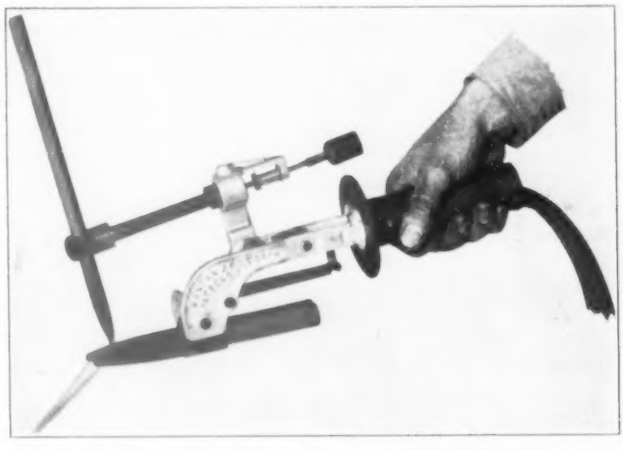
Complete Welding Unit Built for Towing.

This unit consists of a standard single-bearing FlexArc welding generator coupled to a 4-cyclinder gasoline engine having an S.A.E. rating of 28.9 and 42 brake horsepower at the operating speed of 1,450 r.p.m. The generator shunt field is separately excited.

The power unit, generator, exciter, and control equipment are all enclosed in a sheet-metal canopy with removable sides. Heavy-duty pneumatic-tired wheels and spring-borne running gear parts are attached to the welded channel base. The front wheels are steered by the use of radius rods and king bolt construction with an adjustable steering rod for hand or trailer service. The overall dimensions of the complete unit are approximately 93x60x72 in., and the weight is about 3,200 lb.

NEW BULLETIN ON HANSEN "ARC TORCH"

The application of the Hansen "Arc Torch" to various metals and the results obtained, form the subject of a new pamphlet issued by the K. L. Hansen Engineering Co., Inc., 110 E. Wisconsin Ave., Milwaukee, Wis. Particular attention is given to the high-quality work obtained on copper, brass, bronze, and other non-ferrous metals with this tool, and its economical operation compared with the oxy-acetylene torch is pointed out. A description of the "torch" is given, and pictures are shown of the welds obtained on the rotors of squirrel-cage motors, ornamental brass, cast



The Hansen "Arc Torch" Produces a "Soft" Flame.

iron, and aluminum. Mention is made of the "soft" flame produced by the "arc torch," which greatly reduces the convection heat losses and makes it more economical than the combustion flame, as there is no high pressure back of it to blow the metal.

While the results obtained with this "torch" are a high recommendation of its value in the welding and brazing of many non-ferrous metals, it is frankly pointed out that its application to the welding of steel is not all that is to be desired, but the history of its development to date leads one to believe that further experimentation will result in ironing out the present difficulties and make it a desirable tool for the welder in steel and iron as well.

BOOKLET ON RESISTOR-TYPE WELDERS

Variable resistors of various types for furnishing current for metallic-arc welding are described in bulletin GEA-1031B, issued by the General Electric Co., Schenectady, N. Y. Among the features pointed out is the resistor construction which enables the units to withstand rough usage and to resist corrosion. The ohmic resistance and heat-dissipating capacity of one of the types described are of such value as to make the resistor suitable for use with

60-volt constant-potential welding generators. Another type of resistor is designed for mine service, and affords an operating range of from 220 to 275 volts and welding currents from 60 to 200 amp. in 15-amp. steps; it is supplied with a hook or pole for reaching the overhead trolley wire. A third type described is for circuits of 400 to 650 volts and welding currents of 200 and 300 amp., and may be supplied without remote control where desired, which feature allows the operator to break the circuit from the welding position by means of a push-button switch.

NEW CATALOG OF WELDING ACCESSORIES

The line of Fuzon accessories and Weldite supplies made by the Fusion Welding Corp., 10257 Torrence Ave., Chicago, Ill., are listed in a recent catalog. Holders for metallic-arc and carbon-arc welding, eye-protection devices, including the dual-vision helmet, welding gloves, scratch brushes, welding rods and electrodes, cable, and the newly developed Weldite fillet putty, are among the accessories and equipment described. The cover illustrations show collections in which at least one style of each article is represented, thus indicating at a glance the scope of the field covered by the catalog.

WILLIAMS & COMPANY WELDING CHART

The fourth annual issue of the Williams Welding Chart, a handy reference chart of information for welders, is to be available either in folded form, which can be adapted to standard file, or unfolded so it can be tacked up on the wall of the shop for quick reference by foremen and welders. The issue for 1931 will be distributed in January. It will be printed in several colors, and in addition to showing the complete lines of all wires produced by Williams & Company will show the complete line of Wilson welding wires, for which Williams & Company are exclusive distributors in Pittsburgh, Cleveland, and Cincinnati. The chart will also contain useful information in condensed form, such as "Causes of Bad Welds," "Suggestions for Successful Welds," "Recommendations on Technical Points," "Penetration," and "Recommended Practice for Welding Certain Special Metals." The cover of this chart will show an artistic reproduction entitled, "The Welder," adapted from the photographs of unusual arc-welding accomplishments performed on certain of the piping in the Bell Telephone Building at Cleveland, Ohio.

NEW HOBART WELDING MANUAL

The Hobart Brothers Co., Troy, Ohio, manufacturers of Hobart arc-welding generators, have just issued a new welding manual which is of pocket size and contains 80 pages. The subject matter is presented so as to be easily grasped by one not familiar with the process. The welding arc is first discussed and this is followed by a complete discussion of all the items included in the equipment. A chapter devoted to the types of joints and welds gives the student both diagrams and photographs of the designs most commonly used and also includes illustrations which show how the student can set up work so as to get practice on welds of different kinds. A chapter devoted to the weldability of metals deals with those metals which are mostly welded and gives suggestions for the right kind of procedure to follow in each case. Some attention is given to the selection of electrodes, and then the student is given some valuable elementary instruction in actually using the metallic arc. Instructions for carbon-arc welding are also included. There is a chapter of operating instructions for the Hobart welding machine, as well as a chapter devoted to the speed and cost of arc welding. A number of pages at the end of the manual are devoted to illustrations of a great variety of work to which arc welding can be applied both as a repair process and as a production process. The arrangement is logical and the treatment is free from any difficult, technical discussions. An excellent index makes all the subjects discussed readily accessible to the reader.

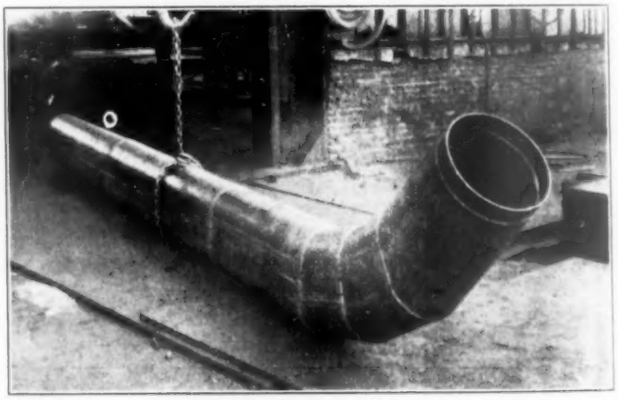
REGO PIPE WELDING MANUAL

The Bastian-Blessing Co., Chicago, Ill., recently published a 44-page manual on pipe welding for use by plumbers, steam fitters, piping contractors, foremen, supervisors, and students. This little manual does not cover the details of oxy-acetylene welding; its purpose is rather to supplement existing textbooks on oxy-acetylene welding by specific information relative to the welding of pipe.

The introduction furnishes a discussion of the reasons for welding pipe. The remainder of the text is divided into five chapters. The first is devoted to the selection of equipment. The second chapter deals with setting up of pipe joints for welding and the preparation of templets for cutting pipe for various types of bends and special connections. The third chapter illustrates the application of welded design to a piping layout. The fourth chapter suggests methods of testing operators for proficiency in pipe welding. The final chapter is a tabulation of average costs for welding refrigerating piping, building piping and long transmission lines, with a set of tables showing the approximate cost of cutting standard-weight and extra-heavy-weight pipe with the oxy-acetylene torch. This little manual is to be distributed to those interested in the subject at the price of 50 cents each.

ORDERS COMING IN FOR WELDED EQUIPMENT

A number of contracts for welded equipment were recently received by the Semet-Solvay Engineering Corp., of New York. Welded steel pipe and fittings of Toncan metal,



Welded Pipe of Oval Section.

Armco, and similar alloys are being demanded. A quantity of pipe and fittings made of Toncan were recently completed for the Solvay Process Co., of Syracuse, N. Y. The pipe runs in size from 8 to 24 in., with special fittings. Welding was done with Toncan welding rods.

The R. H. Baker Co., Cambridge, Mass., have placed orders for a quantity of Semet-Solvay welded steel pipe and fittings. Pipe runs in sizes from 30 to 36 in.

William A. Pope & Co., of Chicago, have ordered a quantity of 72-in. welded steel pipe for the State Line station of the Chicago District Electric Generating Co. This pipe is made from $\frac{3}{16}$-in. steel and shop tested to withstand 25-lb. air pressure. Flanges of forged steel are welded on. The pipe is to be used in the recirculating system.

The Kings County Lighting Co., Brooklyn, N. Y., is installing a quantity of Semet-Solvay 24-in. and 30-in. welded

steel piping for the handling of foul gas. Cast-steel Van Stone flanges are specified.

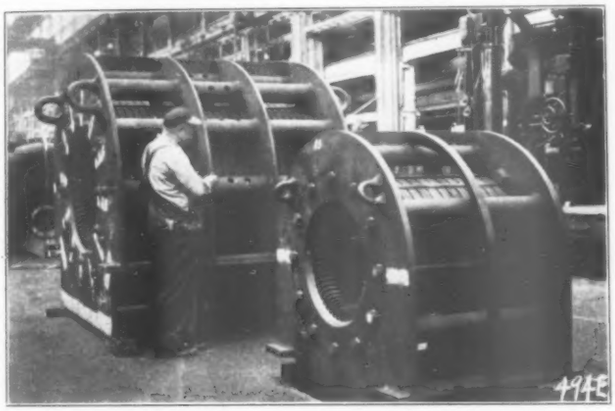
Citizens Gas Fuel Co., of Adrian, Mich., has ordered a two-pass naphthalene scrubber, with necessary pumping and oil-storage capacity. The scrubber is built to handle up to 600,000 cu. ft. of gas in 24 hours.

A quantity of Semet-Solvay welded steel piping is being installed in the steam system of the Eastman Kodak Co., Rochester, N. Y. The piping ranges in diameter from 10 to 36 in.

A shipment of welded steel oval pipe was recently completed for the Lumsden & Van Stone Co., South Boston, Mass. The pipe was equipped with cast-steel flanges and tested to 50-lb. working pressure.

USES PIPE IN ELECTRIC-MACHINERY CONSTRUCTION

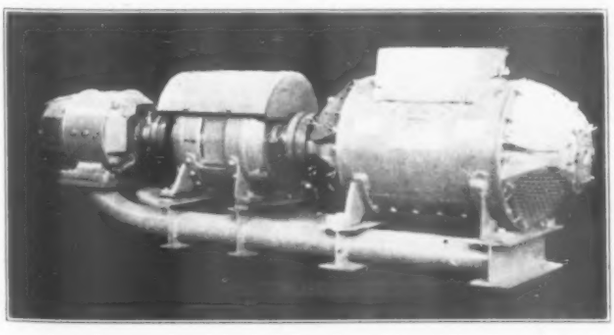
Welded pipes have replaced the usual ribs made of flat bars welded into notches on the outside of turbine-generator frames, in the construction shown in Fig. 1. In



The Pipe in These Welded Generator Frames Replaces Stiffener Bars.

addition to their structural advantages, these tubes serve as air ducts, taking cooling air through the ends and discharging it through holes in the middle. Another novel feature of the design shown are the lifting eyes welded onto the end plates; this eliminates the need of heavy lifting plates on the sides. These lifting eyes may be reached, after the generator is enclosed, through cover plates.

In the small motor-generator set shown in Fig. 2, tubular lengthwise members are used in the bed plate construction. This set was built for use on shipboard, and the tubular construction was chosen as the best shape of section to resist torsional strains that are set up by uneven or yielding foundations. The tubes provide a stronger and more rigid base, and at a considerable saving in weight, with added flexibility in design and reduced manufacturing time. The upward-curving end saves space in that it allows the set to fit more closely to the curvature of the side of the ship. Both equipments illustrated were designed and constructed by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.



Torsional Stresses Are Absorbed by the Tubes in the Base of This Marine Unit.

RYERSON ACQUIRES SHEET-METAL FIRM

The stock and good-will of the sheet-metal division of the Richards Company, Inc., of Boston, Mass., were recently acquired by Joseph T. Ryerson & Son, Inc.

The Richards Company, founded in 1812, has built up a very good business during its 119 years of importing and distributing nonferrous metals, rolling-mill products, and metal workers' supplies. It will continue in business, specializing in pig metals.

Stocks taken over by Ryerson include Armco black and galvanized sheets, lead coated, galvannealed, and Bay State blue sheets, in addition to a diversified line of standard and special sheets which have been carried regularly in the Ryerson warehouses at Third, Binney and Munroe Sts., Cambridge, Mass.

In 1926 the Ryerson organization first entered the Boston territory through the purchase of the reinforcing-bar division of the Penn Metal Co. Two years later the plant, good-will, and steel merchandise of the E. P. Sanderson Co. were added. With the recent purchase, increasing Ryerson sheet-metal facilities, this company has one of the largest and most complete steel-service plants in the New England states. The company also has plants, or is represented, in many industrial centers throughout the country.

WILLIAMS & COMPANY ADD SAFETY LINE

Williams & Company, of Pittsburgh, Pa., have just added another line to their distributing lines, namely, that of the Chicago Eye Shield Co., which includes goggles, hand shields, and helmets for gas and electric welding. Adequate stocks will be carried in Pittsburgh, Cleveland and Cincinnati, and the territory served by Williams & Company will be western Pennsylvania, including Altoona, the states of Ohio, Kentucky and West Virginia, and the western section of Maryland.

ROEBLING TO HANDLE BUSINESS OF NEW JERSEY WIRE CLOTH COMPANY

On and after January 1, 1931, the corporate existence of The New Jersey Wire Cloth Co. will cease, and the business will be continued by the John A. Roebling's Sons Co. The sale and distribution of wire cloth, wire netting, wire fencing, wire lath and wire work will be continued through the parent company at Trenton and through the Roebling branches. The Roebling company will assume all the contracts and obligations of The New Jersey Wire Cloth Co., while the same personnel will continue the manufacture and sale of the entire line.

BANKING INTERESTS PURCHASE LARGE BLOCK OF BLUE TANK STOCK

With the appointment of John A. Vanderpoel as general manager of the Blue Tank Oxygen Co., of Seattle, Wash., comes the information that well-known Seattle financial men have acquired a large percentage of the company's common stock. Mr. Vanderpoel was cashier of the National City Bank previous to its merger with the National Bank of Commerce, of which he became assistant vice-president. He brings to the Blue Tank company a wealth of experience in financial matters and credits. If the company continues its growth as at present indicated, says Mr. Vanderpoel, it will be compelled to expand its financial set-up. Hal H. King, of California, has been appointed sales and advertising manager of the company. Mr. King is well known in

sales and advertising circles all along the coast. The Blue Tank company is the distributor in Washington, Oregon, and British Columbia for the Harris line of welding and cutting apparatus.

NEWS OF THE INDUSTRY

The Lincoln Electric Co. have moved their Chicago office from 53 W. Jackson Blvd. to their new building at 1455 W. 37th St., where a stock is carried of their various welding products, including all the various types of Lincoln welding machines, accessories, and welding wire.

Marcus Hetland, of Wautoma, Wis., recently formed an organization known as the Hetland Welding Service. Mr. Hetland is agent for the Hansen line of electric welders in northern Wisconsin, and also handles a line of oxy-acetylene welding and cutting torches as well as a complete line of supplies. He is planning on mounting a gasoline-driven electric welding unit on a truck, which he will use as his means of travel, so he will always be in a position to demonstrate on the spot; thus he can land his prospects while they are "hot."

C. L. Hughes, of the Engineering Department of the Standard Oil Co., San Francisco, Calif., recently presented a thesis entitled "An Investigation of Two Types of Pressure Vessel Heads," to Standard University as a part of his work for an engineering degree. The thesis describes an investigation of orange-peel and blunt bull-plug ends for pipe lines. It indicates that the orange-peel head can be expected to be twice as strong as the blunt bull-plug, other conditions being equal.

Chester T. Price has been appointed Manager of Gas Sales of Compressed Industrial Gases, Inc., with headquarters at 19 N. Sheldon St., Chicago, Ill. Mr. Price as a former commissioner of Gas Products Association is well known in the industry. He will assume his new duties on January 15th.

The Ray Machine Co., 5403 West Lake St., Chicago, manufacturers of electric screw-driving, nut-setting and tapping machines, has been merged with the R. G. Haskins Co., 4630 W. Fulton St., Chicago, manufacturers of flexible-shaft machinery. W. H. Ray will be associated with the Haskins company, which will continue the manufacture of the appliances formerly made by the Ray company.

A new welding shop, under the name of Starcraft Welders, has been opened at 5218 Bluemound Road, Milwaukee, Wis. This shop is under the management of Fred Rosenbaum and is equipped to handle both acetylene and arc welding.

The November meeting of the Australian Welding Institute included an inspection of a large work shop and a lecture on causes and prevention of explosions. The December meeting featured an inspection trip to an oxy-acetylene-welded building in which is housed a considerable amount of electrically welded machinery and equipment.

On Wednesday, December 3rd, Fred H. Marsh, Sales Manager of Paxton & Vierling Iron Works, Omaha, Neb., read a paper before the Omaha Engineers' Club on the subject of "Welding and Recent Progress in Structural Welding." This paper gave considerable information on the fundamentals of the process and on the progress which has been made in structural applications during the past few years.

H. M. Priest, assistant engineer of the American Bridge Co., New York, discussed the application of arc welding to bridge construction at the fortieth annual convention of the American Railway Bridge and Building Association, which was held at Louisville, Ky., October 21-22.

The Los Angeles agency of Hobart Brothers Electric Welders is being moved from 5710 Santa Fe Ave. to 1316 E. Slauson Ave.

At the fourth regular meeting of the Indianapolis Chapter of the American Society for Steel Treating, which was held Monday evening, December 8, 1930, in the rooms of the Indianapolis Chamber of Commerce, R. Notvest, factory representative of the Northwestern Mfg. Co., Milwaukee, Wis., read a paper on "The Fundamentals and Economics of Arc Welding."

The report of the Committee on Electric Welding Equipment, presented at the twenty-first annual convention of the American Railway Electrical Engineers, held in Chicago, October 21-25, included a recommendation that no specifications should be drawn up for welding equipment for special use in the railroad field, since specifications were already available which practically conformed to railroad requirements.

"Heat Treatment of Nickel-Steel Welds" was the subject of a report by E. H. Behle and C. L. Welch of Washington University read at the meeting of the American Society of Mechanical Engineers held at French Lick, Ind., October 13-15. The paper concluded with the observation that when the weld filler is of the same composition as the original nickel steel, heat treatment will increase the strength of the weld in proportion to the increase in strength it produces in the solid stock.

At the December meeting of the Institution of Welding Engineers, London, which was held on December 11th, the feature of the program was a paper on the subject of "Fabrication of Acid-Resisting Steels" which was illustrated by a motion-picture film and lantern slides.

R. K. Randall, proprietor of the Cleveland Welding School, writes that he recently installed one of the new Hansen electric-carbon-arc brazing outfits in order to give students an opportunity to practice electric brazing.

Martin Olsen, formerly welding supervisor for the Mojonnier Brothers Co., Chicago, sailed this month to assume duties as welding foreman for the M. W. Kellogg Company, at Aruba, Dutch West Indies.

Changes in personnel of the Pacific Coast offices of The Lincoln Electric Company, Cleveland, Ohio, include the appointment of S. H. Taylor, Jr., in charge of the coast, with headquarters at 812 Mateo St., Los Angeles, Calif., succeeding W. S. Stewart, who has been appointed district manager of the Cleveland territory of the company; the appointment of L. P. Henderson as manager of the San Francisco office; also the appointment of E. J. Pfister, formerly of the Philadelphia and Allentown offices, as manager of the Kansas City district, with offices at 405 R. A. Long Bldg., 10th and Grand Sts., in that city. It is also announced that the Philadelphia office of the company has been moved to the Commerce Building in that city, where additional space is provided for the sales and service of arc welders, motors, and welding supplies, and for making tests on arc-welded designs. The Philadelphia office is in charge of D. C. Anderson.

Notice has been received that the date for the annual meeting and dinner of the Compressed Gas Manufacturers Association has been set for Monday, January 19, 1931. The meeting place will be at the Hotel Astor, New York City. Reservations for the dinner should be made to the Compressed Gas Manufacturers Association at 110 West 40th St., New York City.

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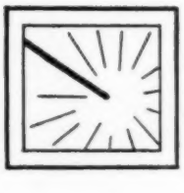
ROEBLING  WELDING WIRE

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See "Electric Resistance Welders"
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SPOT WELDERS
See "Electric Resistance Welders"
TANK CONNECTIONS
Air Reduction Sales Co.
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TUBE-TURNS
Tube-Turns, Inc.
UNDER WATER CUTTING EQUIPMENT
Craftsweld Equipment Co.
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VALVES
Air Reduction Sales Co.
Bastian-Blessing Co.
Oxweld Acetylene Co.
WELDING COMPOUND (for Shape Welding
Air Reduction Sales Co.
Harris Calorific Co.
National Carbon Co.
WELDING RODS AND WIRE
See "Electrodes" and "Acetylene Welding Wire"

ALPHABETICAL INDEX TO ADVERTISERS

A
Agnew Electric Welder Co. ... 74
Air Reduction Sales Co. ... 3
Allan Mfg. & Welding Co., Inc. ... 74
American Brass Co., The ... Front Cover
American Rolling Mill Co., The ...
American Steel & Wire Co. ... Inside Front Cover
American Transformer Co. ...
American Welding Society ...
Amico Novelty Corp. ...
Anti-Borax Compound Co. ... 74
Arcway Equipment Co. ...
Associated Business Papers, The ... 14
Atlas Foundry Co., The ...

B
Bastian-Blessing Co., The ... 73
Bonney Forge & Tool Works ... 67
Bridgeport Brass Co. ...
Burke Electric Co. ... 21

C
Central Steel & Wire Co. ... 9
Chase Brass & Copper Co., Inc. ...
Commercial Acetylene Supply Co., Inc. ... 68
Continental Motors Corp. ... 11
Craftsweld Equipment Corp. ...
Crown Aluminum Solder Co. ... 66

D
Duff-Hall Goggle Service ...

E
Elec. Arc Cutting & Welding Co., Back Cover
Electric Welding Machine Co., The ...
Elkon, Inc. ...

F
Faulk, F. R. ...
Federal Machine & Welder Co. ... 72
Fibre-Metal Products Co., The ... 67
Fusion Welding Corporation ...

G
General Electric Co. ...
General Welding & Equipment Co. ...

H
Handy & Harman ... 74
Harris Calorific Co. ... 26
Harrisburg Pipe & Pipe Bending Co. ... 10
Haynes Stellite Co. ... 15
Hobart Brothers ... 70
Holcomb Safety Garment Co. ... 72
Hollup Corporation ... 66

I
Ideal Face Shield Co., The ... 74
Imperial Brass Mfg. Co., The ... 71
Innis, Speiden & Co. ...

K
Keller Mechanical Engineering Corp. ... 72
K-G Welding & Cutting Co., Inc. ... 64
Koro Corporation ...

L
Lanyard Sales Co. ... 74
Lincoln Electric Co., The ... 19
Linde Air Products Co., The ...
Lotan Research Corp. ...

M
Matchless Utilities Co. ...
Metal and Thermit Corp. ... 16
Micro Products Co. ...
Motor Meter Gauge & Equipment Corp. ... 17
Mueller Brass Co. ... 20

N
National Carbide Sales Corp. ... 64
National Carbon Co., Inc. ...
Northwestern Mfg. Co. ... 70

O
Owen Electric Mfg. Co. ... 73
Oxweld Acetylene Co. ...

P
Page Steel & Wire Co. ... 13
Pressed Steel Tank Co. ... 69
Prest-O-Lite Co., Inc., The ...
Pulmosan Manufacturing Co. ...

Q
Quasi-Arc, Incorporated ... 74

R
Reid-Avery Co., Inc. ...
Roebling, John A., Sons Co. ... 1
Rome Wire Co. ...
Ryerson, Joseph T., & Son, Inc. ... 75

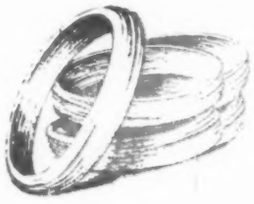
S
Seneca Wire & Mfg. Co. ... 65
Service Co. ... 74
Shawinigan Products Corp. ... 72
Shoot-A-Lite Corp. ...
Southwark Foundry & Machine Co. ...
Standard Steel & Wire Co. ...
Steel Sales Corp. ...
Strand, N. A., & Co. ... 67
Stoody Co. ... 28
St. Paul Welding & Mfg. Co. ... 76
Superior Alloys Corp., Ltd. ... 74
Superior Oxy-Acetylene Machine Co. ...

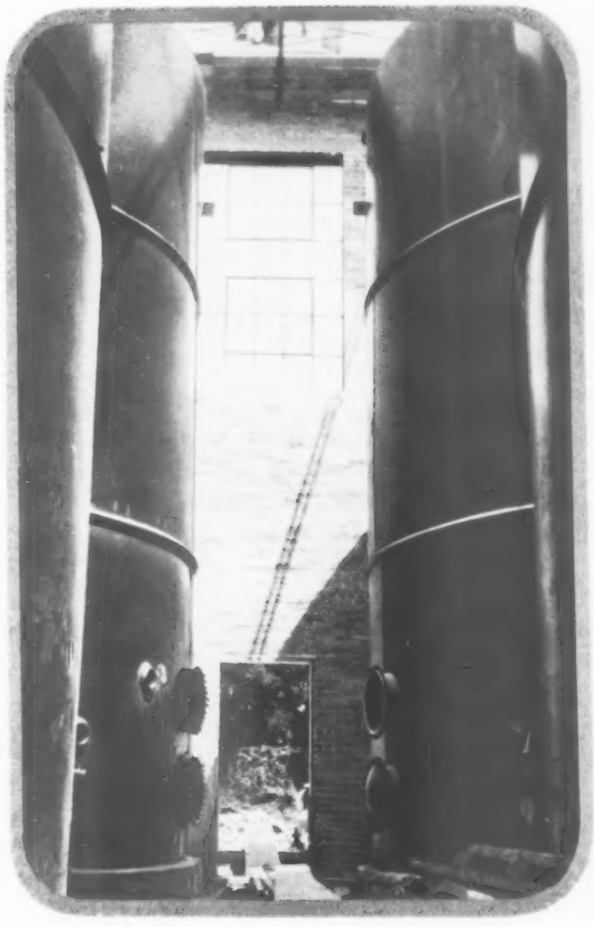
T
Taylor-Wharton Iron & Steel Co. ...
Taylor-Winfield Corp., The ... 74
Torchweld Equipment Co. ... 65
Tube-Turns, Inc. ... 24

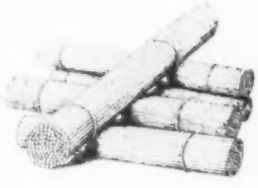
U
Under-Water Metal Cutting Corporation ...
Union Carbide Sales Co. ...
Union Carbide & Carbon Corp. ... 12

V
Victor Welding Equipment Co. ...

W
Warner Engineering Corp., The ... 71
Welding Engineering and Research Corp. ...
Welding Service Co. ...
Weldit Acetylene Co. ... 69
Westinghouse Electric & Mfg. Co. ...
Wickwire Spencer Steel Corp. ... 68
William Wharton Jr. & Co., Inc. ...
Williams & Company, Inc. ... 71
Willson Products, Inc. ... Inside Back Cover
Wilson Welder & Metals Co. ... 7







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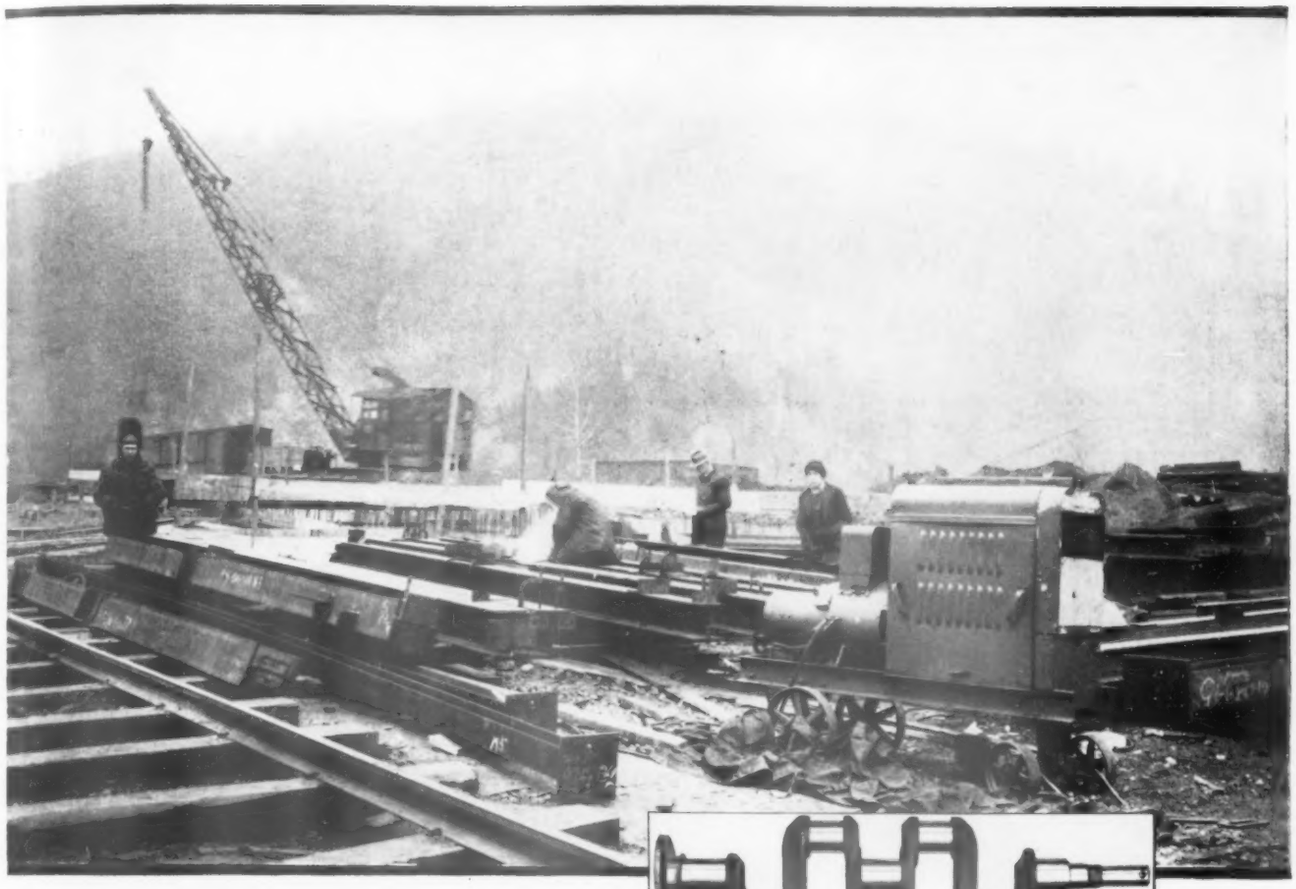

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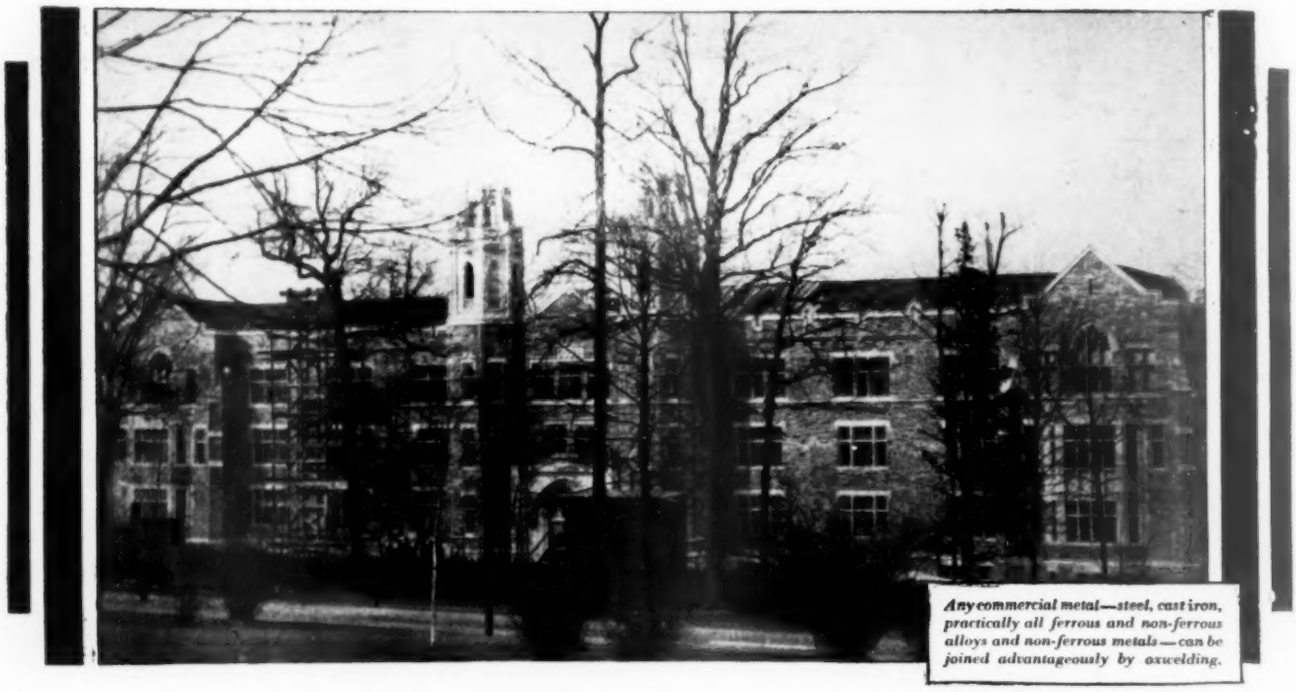

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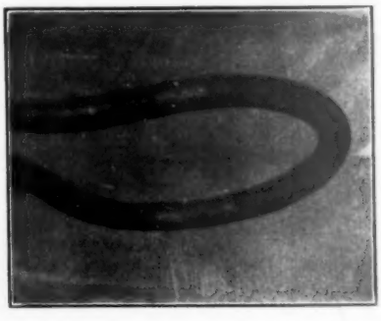
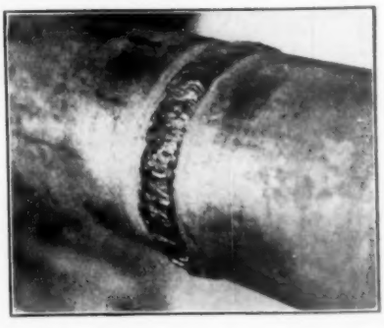
At Lehigh University Packard Laboratory Piping is Oxwelded





OXWELDING was selected as the means of installing the piping system of the James Ward Packard Laboratory because of its many advantages over other methods of pipe joining. It lowered costs in every step of the installation. Design was simplified. Fittings were fabricated from standard pipe section. Weight was reduced. Insulation was facilitated and less time was required to complete the job.

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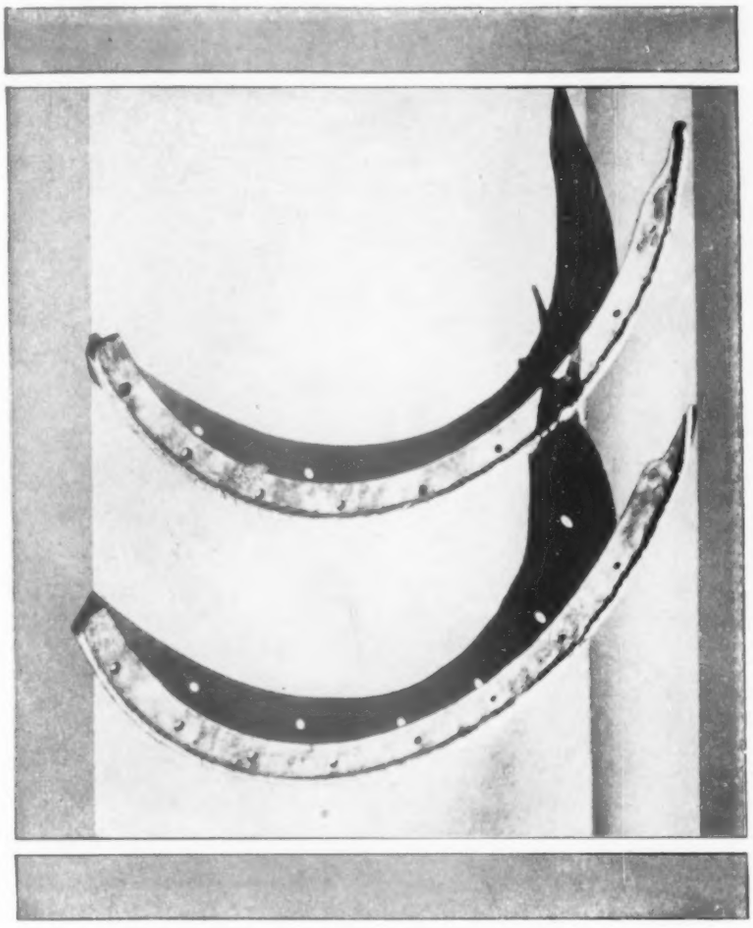

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Thermit Welding is standard in most of the large steel mills for welding heavy sections and for building up worn parts. The Thermit process is the most economical and permanent method of doing such work. In manufacturing processes where large castings are required the method of making smaller units and welding them together to make a completed job is the most economical way of doing the work.

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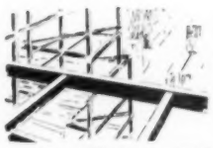
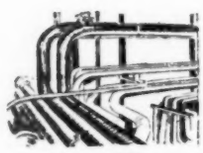
What's Next in Welding?



IN THE STRUCTURAL steel field, welding is recognized as a coming method of assembly. City and State building codes are permitting it. Acceptable standard codes and model specifications are available to building commissions and architects. Much fundamental design data has accumulated. It is even predicted that city building laws of the future will prohibit riveting on account of its noise. An enormous new market here for all of the welding processes.

THE RAILWAY TRANSportation field, tank cars and locomotive tenders, all-welded, promise much new work. Experiments in this direction have been eminently successful.

IN THE FIELD OF PRESsure vessel welding the old superstitions regarding the dependability of a weld are giving way to sound knowledge and common sense. Welding is not far from its rightful place in pressure vessel construction. When it gets properly established a flood of orders for welded pressure vessels will be forthcoming.



IN THE FIELD OF DOMESTic and industrial piping welding is gaining favor by leaps and bounds. Union steamfitters in all sections of the country are being organized into school groups to learn welding. One chain of 130 schools has a special group at work on the preparation of welding instruction for plumbing and heating apprentices.

IN THE FIELD OF WATER transport the volume of new work is equally great. Several large companies are building welded steel barges, one of them now producing at the rate of three a week. The development of our inland waterways will multiply the demand for this welding product.

IN THE FIELD OF SHEET metal fabrication welding is gaining new friends every day. Improvements in hand and automatic arc and gas welding, improvements in welding wire, improvements in spot, seam, flash and projection welding make welding possible on products hitherto considered unweldable. Popular demand for small refrigeration units, coupled with the need for welding on this equipment creates a huge welding industry on this product alone.

Who are the men in these industries who will advance most rapidly, and enable their employers to make the greatest welding progress? They are the men who are interested enough in their work to read about it, to study it, to search for new ideas. To these men The Welding Engineer will bring during the next twelve months the latest and best information obtainable on *design, procedure, materials, organization, supervision* and *testing*. Subscribe now, and keep in touch with the progress made by the leaders of your industry.

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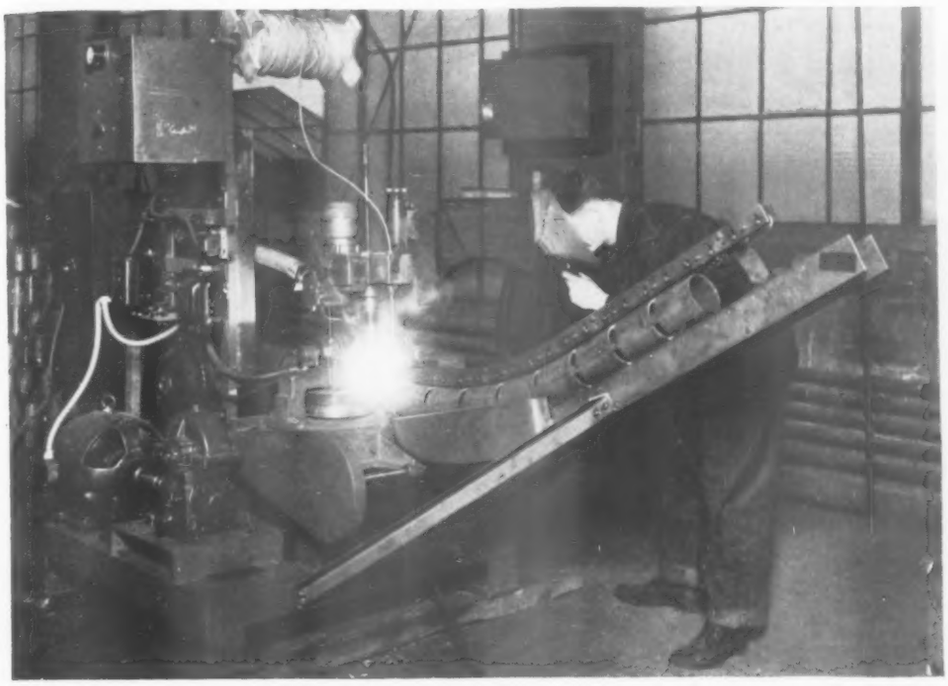

★ Automatically welding automobile starter and generator frames by the Lincoln Electronic Tornado process, which utilizes the shielded arc. Below is shown a generator frame after welding.

TRADITION

"WHAT a boost we could give to the automotive industry if we could only bring about an improvement as great as the self-starter . . ."

PROGRESS

"All right, and if we can't improve the auto we can at least improve its production. I'll show you a case right in that self-starter field where they did just that by means of the 'Electronic Tornado' process.

By utilizing Lincoln's shielded arc for the production of starter and generator frames they now pop them out at the rate of *240 per hour.*

Formerly they used seamless tubing. Now they use 5/16" and 3/8" steel plate formed into shape and butt welded automatically.

And, Pop, there are other automotive products, automatically welded by the 'Electronic Tornado's' shielded arc, such as torque tubes, brake cross shafts, rear axle housings, wire and disc wheels and other parts.

Pipe, tanks, machinery parts, boilers, safes, battleship deck type of steel floors and grave vaults are a few of the products the 'Electronic Tornado' welds in other industries.

And this little idea on automatic production (see illustration) has brought to the manufacturer the same convenience as the starter brought to the driver . . . with this exception: the driver can't make *240 per hour* and live at home."

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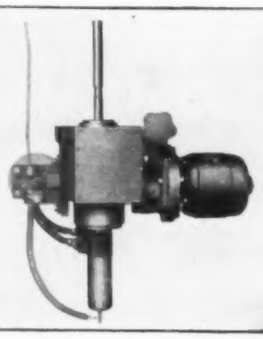

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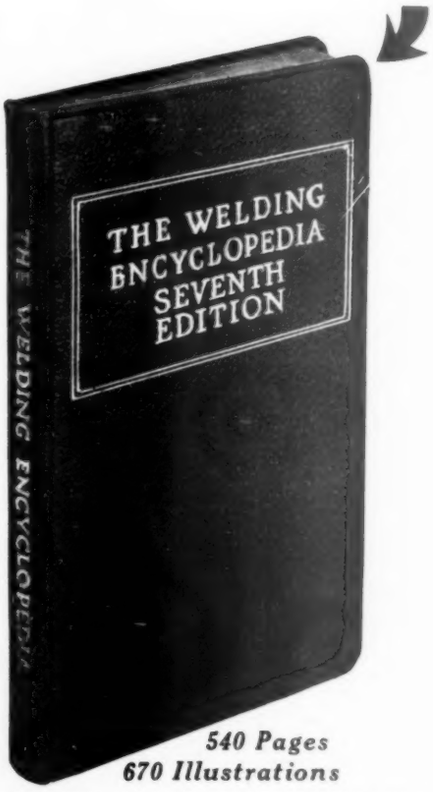

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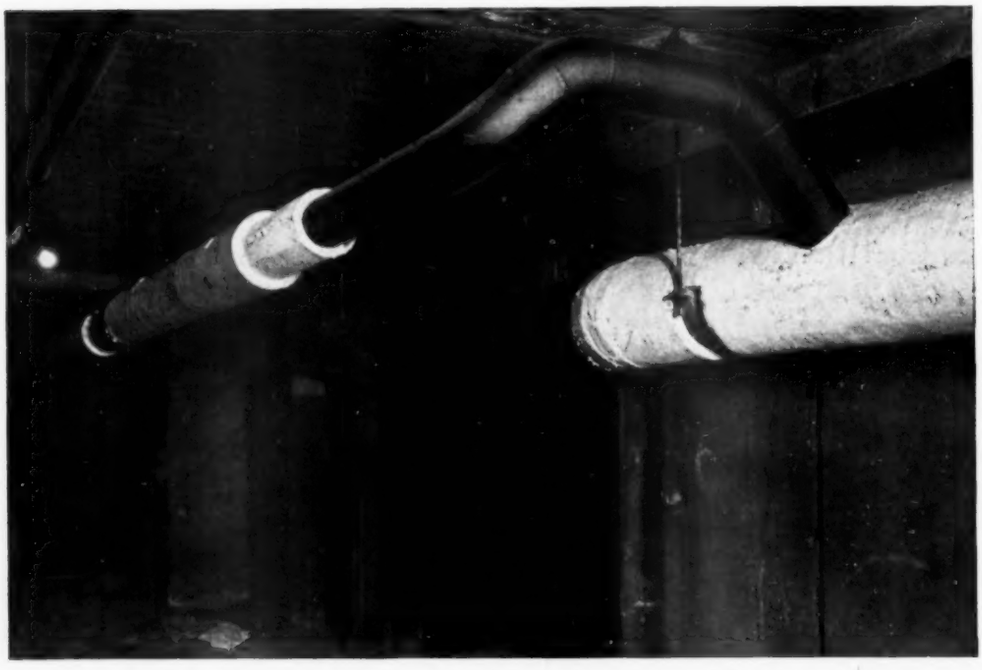

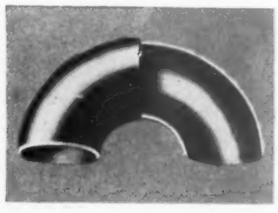

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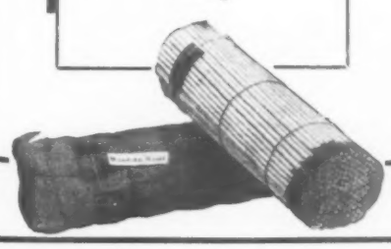

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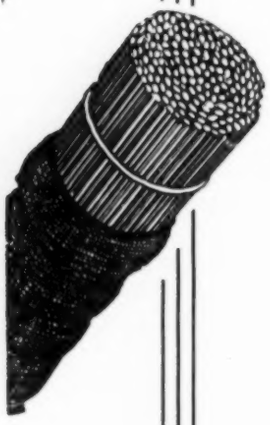

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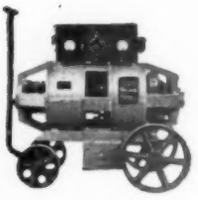

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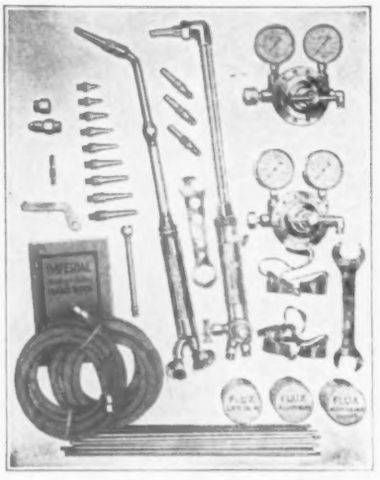

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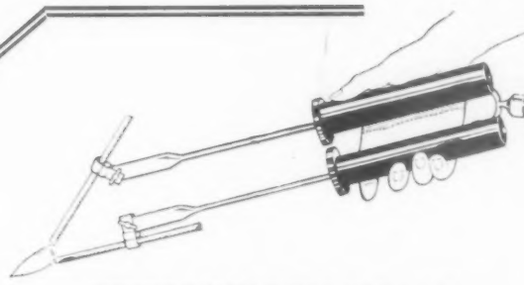

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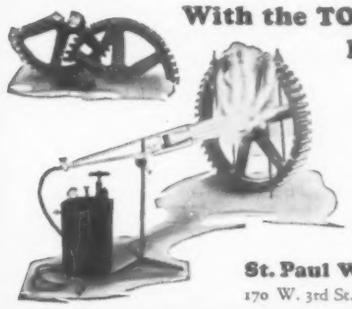

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